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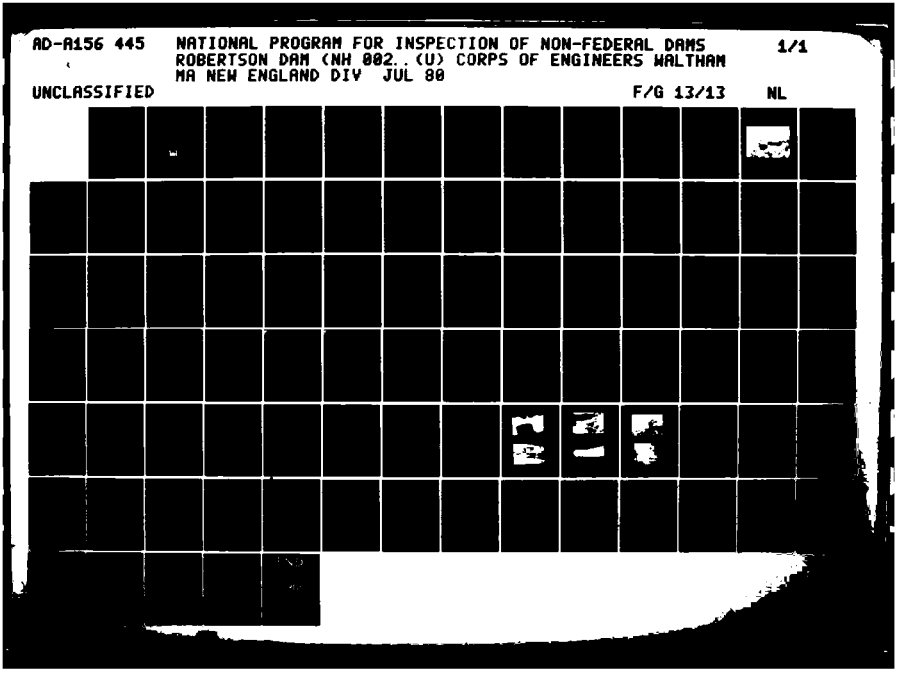

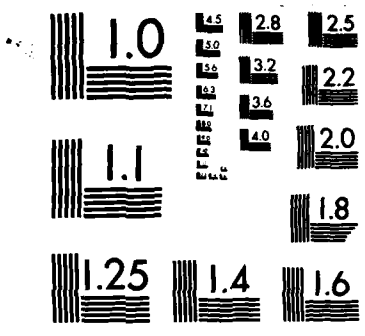

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AD-A156 445

CONNECTICUT RIVER BASIN

WINCHESTER, NEW HAMPSHIRE

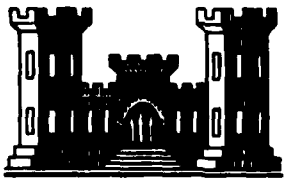
ROBERTSON DAM

NH 00276

NHWRB NO. 255.02

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM



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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,
Connecticut River Basin
Winchester, New Hampshire
Ashuelot River

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The dam is a run of the river dam consisting of a rock filled timber crib overflow section capped with a 10 inch thick concrete slab. It is 150 ft. long with a maximu height of 17 ft. The maximu storage capacity at top of dam is 112 acre ft. THe dam is considered to be in poor condition. The dam is small in size with a significant hazard potential.

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CONNECTICUT RIVER BASIN
WINCHESTER, NEW HAMPSHIRE

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

NATIONAL DAM INSPECTION PROGRAM
PHASE I - INSPECTION REPORT
BRIEF ASSESSMENT

Identification No: NH 00276

Name of Dam: Robertson Dam

Town: Winchester

County and State: Cheshire, New Hampshire

Stream: Ashuelot River

Date of Inspection: June 17, 1980

Robertson Dam is a run-of-river dam consisting of a rock filled timber crib overflow section capped with a 10-inch thick concrete slab. The overall length of the dam is 150 feet, with a maximum height of about 17 feet. The overflow section is about 101 feet long between training walls and approximately 12 feet high from downstream channel bottom to top of permanent crest. Located adjacent to the right training wall is a 35 feet long by 1.8 feet deep low flow spillway cast into the concrete slab capping the overflow section. The left training wall is constructed of concrete and extends about 5.0 feet above the crest of the overflow section. Located approximately 50 feet upstream from the left training wall is the intake for a penstock which supplies process water to the adjoining mill. The right training wall is constructed of dry cut stone masonry partially faced with concrete. Located in the stone masonry section of the right training wall, about 30 feet upstream of the dam crest, are a series of waste gates. These gates have been blocked with stone rubble dumped on the upstream face of the right training wall and are inoperable.

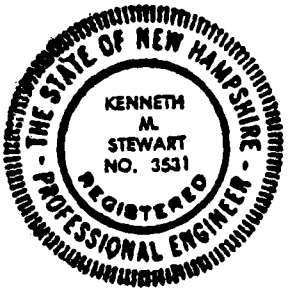
The dam impounds water from the Ashuelot River which, after passing over the spillway, flows in a westerly direction through the town of Hinsdale. The original purpose of the dam apparently was to generate hydroelectric power, but all generating capability has been abandoned, and the present purpose of the dam is to provide process water to the adjoining paper mill. The pool behind the dam is normally 0.47 miles in length with a surface area of about 8.6 acres. The maximum storage capacity at top of dam is 112 acre-feet.

As a result of the visual inspection of this facility, the dam is considered to be in POOR condition. Major concerns are: major leakage in the right abutment area; two major cracks in the concrete facing at the right training wall; trees and brush growing along the crest and from the back face of the stone masonry section of the right training wall; settlement in the crest of the overflow section; the section of concrete cap that has broken free at the left side of the crest of the low flow spillway; major discharge of water from the left bank of the downstream channel at the toe of the dam; and lack of surface erosion protection on the downstream face of the left abutment. The lack of an operating low level outlet that would allow drawdown of the pool below the low-flow spillway crest is considered to be a deficiency rather than a major concern.

This dam is classified as SMALL in size and a SIGNIFICANT hazard structure in accordance with the recommended guidelines established by the Corps of Engineers. The test flood for this dam, therefore, ranges from the 100-year flood to one-half the Probable Maximum Flood (1/2 PMF). The 100-year flood was selected for this hydrologic analysis since the dam falls at the lower end of the range of storages given for the small size classification. The test flood inflow was estimated to be 9,150 cfs. The surcharge storage calculations indicated that there would be virtually no attenuation of the test flood inflow and that the routed test flood outflow would overtop the dam crest by about 2.1 feet. The capacity of the overflow section with the water surface at the dam crest was estimated to be about 5,300 cfs, which is about 58 percent of the routed test flood outflow. An assumed breach with the water surface at the dam crest would cause an increase in stage of about 3 to 4 feet above the downstream prefailure tailwater, bringing the water surface to a point about 2 to 3 feet above the sill of portions of the mill buildings located adjacent to the river channel. The potential for economic loss, as well as for the loss of less than a few lives would exist.

It is recommended that the owner engage a qualified registered engineer to investigate the leakage at the right abutment; design repairs for the two major vertical cracks in the concrete facing at the right training wall; specify procedures for removal of trees and brush from the right training wall; investigate the settlement in the crest of the overflow section; investigate the discharge of water from the left bank of the downstream channel at the toe of the dam; specify erosion protection for the downstream face of the left abutment; perform a detailed hydrologic-hydraulic investigation to assess further the potential for overtopping the dam and the need for and means to increase project discharge capacity; assess the need for and means to provide a low level regulating outlet that would allow drawdown of the pool; and inspect the downstream face of the overflow section under no flow conditions. It is also recommended that the owner repair all cracked and eroded concrete and clear the trees and brush from the right abutment.

The recommendations and remedial measures are described in Section 7 and should be addressed by the owner within one year after receipt of this Phase I Inspection Report.



Kenneth M. Stewart
Project Manager
N.H.P.E. 3531

S E A Consultants Inc.
Rochester, New Hampshire

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and

rarity of such a storm event, finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

The Phase I investigation does not include an assessment of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespassing and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

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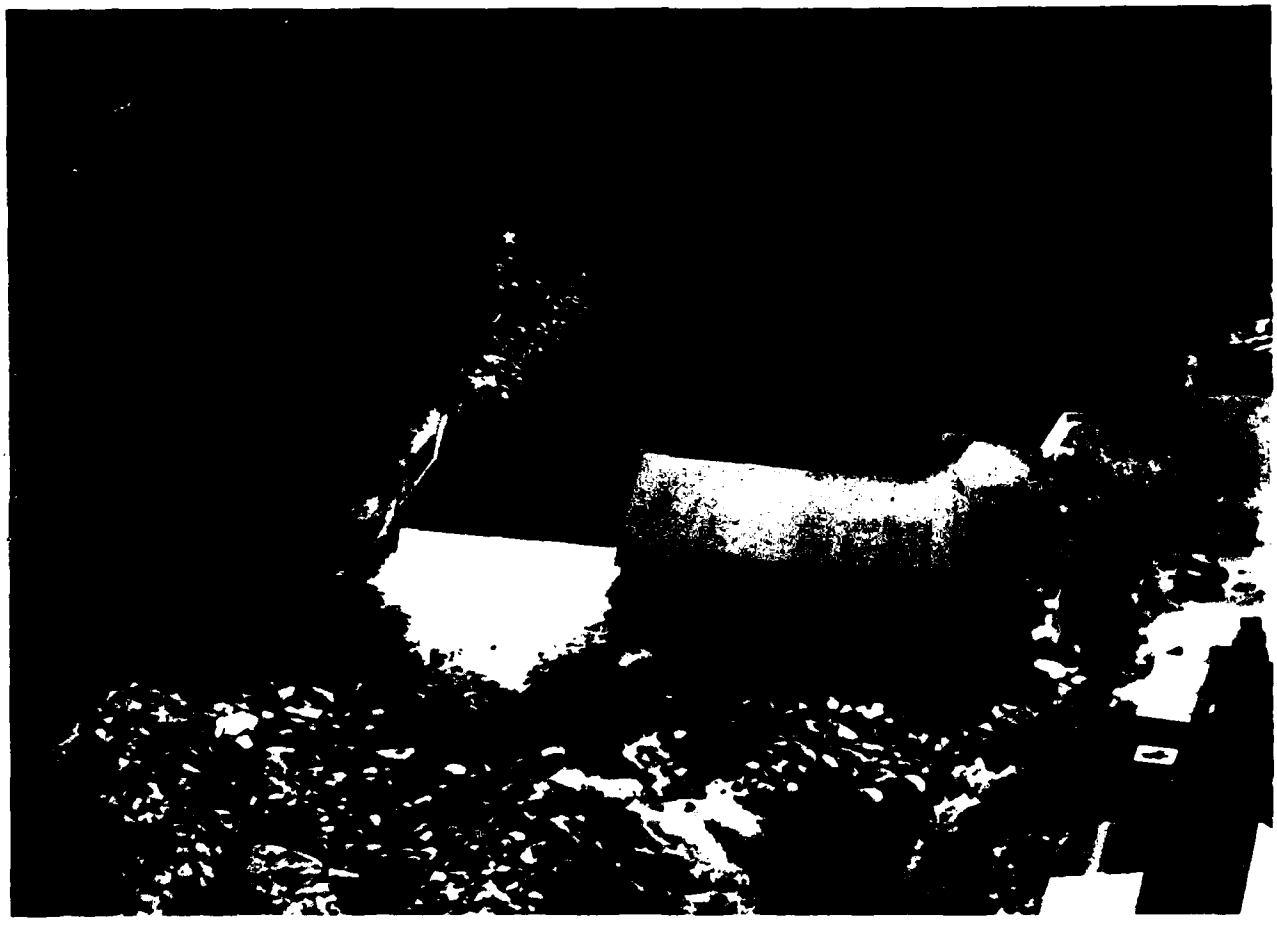
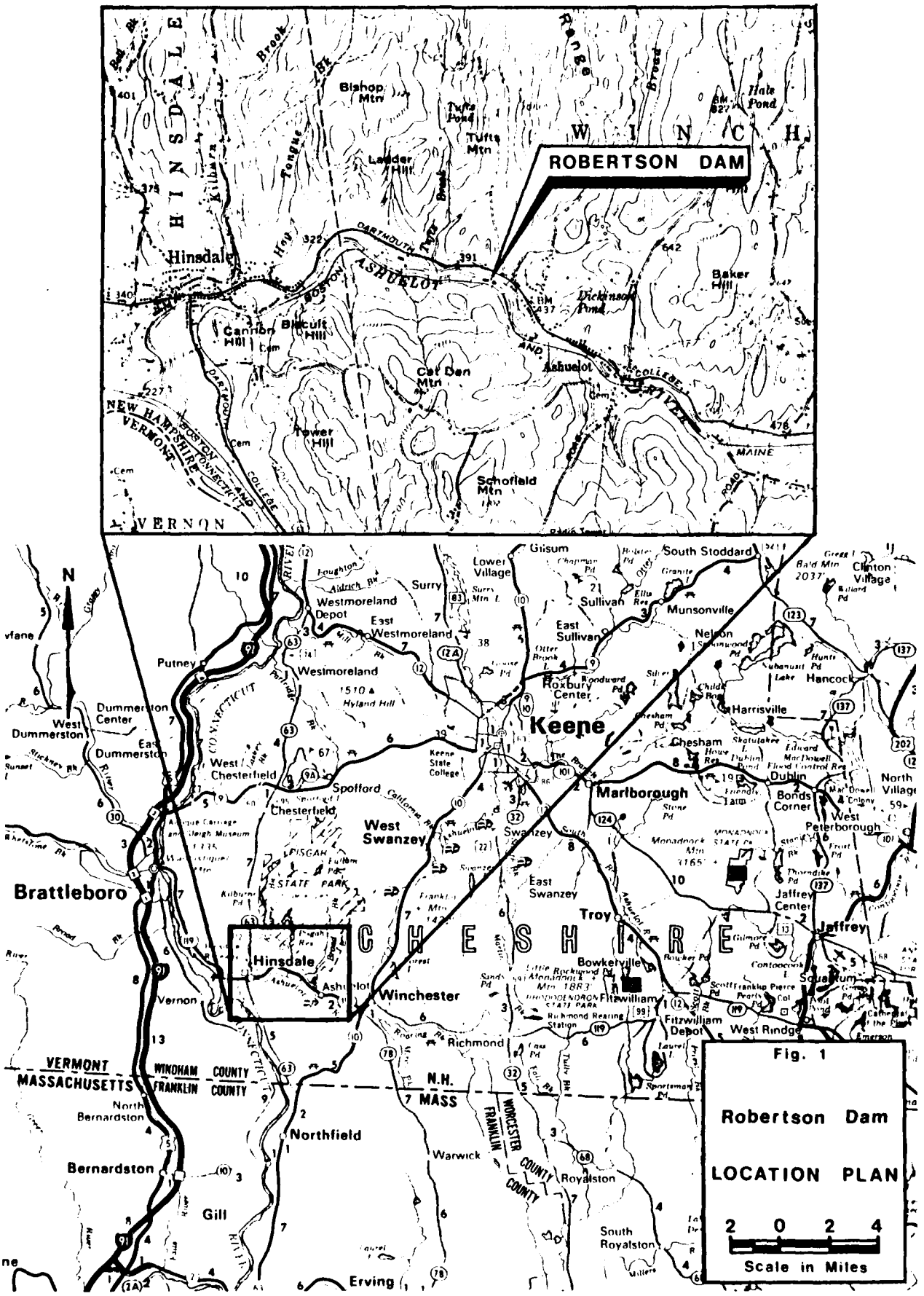


OVERVIEW PHOTO - ROBERTSON DAM


ROBERTSON DAM
HINSDALE
WINCH
Bishop Mtn
Tufts Mtn
Ladder Hill
Hale Pond
Baker Hill
Dickinson Pond
Hinsdale
Ashuelot
Cannon Hill
Biscuit Hill
Cat Den Mtn
Tower Hill
Schofield Mtn
NEW HAMPSHIRE
VERMONT
MAINE
VERNON
Gilsum
Lower Village
South Stoddard
Clinton Village
Surry
Westmoreland Depot
East Westmoreland
Westmoreland
Sullivan
East Sullivan
Munsonville
Nelson
Putney
Roxbury Center
Keene
Harrisville
Hancock
Dummerston Center
West Dummerston
East Dummerston
West Chesterfield
Spofford
Chesterfield
Chesham
Dublin
Marlborough
Bonds Corner
West Peterborough
North Village
West Swanzey
Swanzey
East Swanzey
Troy
Jaffrey Center
Jaffrey
Brattleboro
Hinsdale
Vernon
Winchester
Bowkerville
Fitzwilliam
Fitzwilliam Depot
West Rindge
Richmond
Northfield
Warwick
Royalston
South Royalston
Bernardston
North Bernardston
Gill
Erving
VERMONT
MASSACHUSETTS
WINDHAM COUNTY
FRANKLIN COUNTY
N.H.
MASS
WORCESTER COUNTY
CHESHIRE
Fig. 1
Robertson Dam
LOCATION PLAN
2 0 2 4
Scale in Miles

X

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT
ROBERTSON DAM

SECTION 1
PROJECT INFORMATION

1.1 General

a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. S E A Consultants Inc. has been retained by the New England Division to inspect and report on selected dams in the state of New Hampshire. Authorization and notice to proceed were issued to S E A Consultants under a letter of November 5, 1979 from William Hodgson, Jr., Colonel, Corps of Engineers. Contract No. DACW33-80-C-0008 has been assigned by the Corps of Engineers for this work.

b. Purpose

(1) To perform technical inspection and evaluation of non-federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-federal interests

(2) To encourage and prepare the states to initiate quickly effective dam safety programs for non-federal dams

(3) To update, verify and complete the National Inventory of Dams

1.2 Description of Project

a. Location. Robertson Dam is located in the town of Winchester, New Hampshire on the Ashuelot River approximately 1.22 miles upstream of the Hinsdale-Winchester town line and 3.6 miles upstream of the confluence with the Connecticut River. The dam impounds water from the Ashuelot River which, after passing over the spillway, flows in a westerly direction through the town of Hinsdale, New Hampshire. The dam is shown on U.S.G.S. Quadrangle, Keene, New Hampshire, with coordinates approximately at N42°47'16", W72°26'35", Cheshire County, New Hampshire. (See Location Plan)

b. Description of Dam and Appurtenances. Robertson Dam is a run-of-river dam consisting of a rock-filled timber crib overflow section capped with a 10-inch thick concrete slab. The overall length of the dam is 150 feet, with a maximum height of about 17 feet. The overflow section is about 101 feet long between training walls and approximately 12 feet high from downstream channel bottom to top of permanent crest. The upstream face slopes approximately 1 foot vertical to 2.6 feet horizontal from crest of overflow section to upstream channel bottom.

The downstream face slopes approximately 1 foot vertical to 2.6 feet horizontal from crest of overflow section to end of concrete cap. From this point the downstream face is vertical for about 4.5 feet to the downstream channel bottom. Located adjacent to the right training wall is a 35 feet long by 1.8 feet deep low flow spillway cast into the concrete slab capping the overflow section. The downstream face of the low flow spillway slopes approximately 1 foot vertical to 3.5 feet horizontal to end of concrete cap. From this point the downstream face is vertical for about 4.0 feet to the downstream channel bottom.

The left training wall is constructed of concrete and extends about 5.0 feet above the crest of the overflow section. The wall is about 16 feet long, 0.5 feet thick at the top, and has a batter on the river face of about 4 feet vertical to 1 foot horizontal. Located approximately 50 feet upstream from the left training wall is the intake for a penstock which supplies process water to the adjoining mill. Flow through the penstock is controlled by wooden planks which are placed against the upstream face of the intake structure.

The right training wall is constructed of dry cut stone masonry partially faced with concrete. The stone masonry section is parallel to the river and is at least 72 feet long, varies in thickness from 8.0 to 10.0 feet and extends between 9.0 and 10.5 feet above the crest of the low flow spillway. The concrete facing is about 35 feet long, varies in thickness from 0.5 to 1.5 feet and extends about 7.5 feet above the crest of the low flow spillway. According to an old sketch of the dam (see p. B-13) four gates are located in this stone masonry section upstream from the overflow section. Only two of these gates could be found at the time of inspection. Debris had been dumped on the upstream side of these gates to seal them off and debris apparently covered the downstream side of two of the gates. Consequently, all four gates are no longer functional. The two gates which were observed measured 4 feet by 4 feet, with an invert elevation of approximately 377 feet (NGVD).

c. Size Classification. Small (height - 17 feet; storage - 112 acre-feet) based on storage (greater than or equal to 50 acre-feet and less than 1,000 acre-feet) as given in the Recommended Guidelines for Safety Inspection of Dams.

d. Hazard Classification. Significant Hazard. The discharge resulting from an assumed failure of the Robertson Dam would cause an increase in stage of about 3 to 4 feet above the downstream prefailure tailwater, bringing the water surface to a point about 2 to 3 feet above the sill of portions of the mill buildings adjacent to the river channel. The potential for economic loss as well as the loss of less than a few lives would exist.

e. Ownership. No information regarding the original structure or owner was found. Early records indicate the dam to be in existence by 1919. Inspection reports dated during the 1930's indicate the owner to be Public Service Company of New Hampshire, with the Robertson Brothers Paper Mill as lessee and operator. The present owner is Paper Service Mills, Hinsdale, New Hampshire 03451; Russell O'Neal, Manager. Telephone No. (603) 239-4791.

f. Operator. The dam is maintained and operated by Paper Service Mills, Hinsdale, New Hampshire 03451; Russell O'Neal, Manager. Telephone No. (603) 239-4791.

g. Purpose of Dam. The original purpose of the dam apparently was to generate hydroelectric power. All generating capability has been abandoned and the present purpose of the dam is to provide process water to the adjoining paper mill.

h. Design and Construction History. No information regarding the design and construction of the original structure was found. From inspection reports, it can be determined that the original structure consisted of a 175 feet long plank covered timber crib overflow section with 2 feet high flashboards constructed between the mill building on the left abutment and a stone masonry training wall at the right abutment. Two intake gates at the left abutment provided water to a turbine and a wheel to generate electricity. Four waste gates and a gate house were located at the right training wall. Extensive repairs were made in 1927 and in 1936, but the basic configuration of the dam remained unchanged. In the early 1970's, extensive renovations were made changing the dam to its current configuration. Major changes included shortening of the overflow section by 75 feet and complete reconstruction of the left abutment, pouring a concrete cap over the timber crib overflow section and placement of stone rubble on the upstream face of the right training wall blocking the waste gates.

i. Normal Operating Procedures. There is no formal operating procedure for this dam since there are no functional operating facilities incorporated into the dam. There is no gate on the process water penstock, so flow is controlled with long planks placed on the upstream face of the penstock intake structure to either partially or completely block the inlet.

1.3 Pertinent Data

a. Drainage Area. The drainage area above Robertson Dam covers approximately 406 square miles (nearly 260,000 acres), consisting of hilly and mountainous terrain, surrounding numerous lakes, ponds and swampy areas which eventually drain to the dam. There are a number of small dams located on the lakes and ponds in the watershed, as well as two Corps of Engineers flood-control dams. The Surry Mountain Dam which is located on the Ashuelot River north of Keene has a storage capacity of approximately 32,500 acre-feet and intercepts runoff from a drainage area of about 100 square miles. The Otter Brook Dam which is located on Otter Brook to the east of Keene has a flood storage capacity of approximately 17,600 acre-feet and intercepts runoff from a drainage area of about 47 square miles.

The topography in the drainage basin ranges from 3,165 feet NGVD on top of Mount Monadnock to approximately 366 feet NGVD at the base of the dam. The majority of the basin is heavily wooded. Development in the drainage basin is quite variable ranging from large sections of undeveloped land to more extensively developed portions around towns and tourist areas.

b. Discharge at Damsite. Discharge at the damsite normally occurs over the 101 feet long concrete capped overflow section located between the concrete training walls. A 35 feet long low flow spillway is located in the overflow section adjacent to the right training wall. The low flow spillway is nearly 1.8 feet deep with the weir crest set at an elevation of 380.46 feet (NGVD). The elevation of the remainder of the overflow section varies, since it appears that a portion of the crest has settled. The elevation of the overflow section weir crest ranges from a low of 381.4 feet to a maximum of 382.54 feet. A penstock which supplies process water to the mill is located approximately 50 feet upstream from the left training wall. Water entering the penstock is eventually passed on to the mill's wastewater treatment facility. The size and invert elevation of the penstock could not be determined. Located in the stone masonry section of the right training wall are a series of waste gates. Two gates were observed during the inspection. However, records on file at the New Hampshire Water Resources Board indicate that originally four gates existed. The two observed gates have been blocked with stone rubble and are inoperable. A small amount of leakage was emanating from the two gates at the time of inspection.

(1) Outlet works (conduits) - Not functional

(2) Maximum known flood at damsite - Based on information from USGS Gage No. 01-161-000 which is located on the Ashuelot River in Hinsdale about 1.2 miles upstream from the confluence with the Connecticut River (about 2.4 miles downstream of the Robertson Dam), the maximum flood at the damsite would have occurred on March 19, 1936. The estimated discharge at the gaging station was 16,600 cfs. However, this flood occurred prior to the construction of two flood control dams which are located upstream from the Robertson Dam, and prior to reconstruction of the Robertson Dam, which occurred in the early 1970's. Since that time, discharges of 6,040 cfs and 6,010 cfs were recorded at the gaging station on December 12, 1973 and March 9, 1979, respectively. The owner reported that the latter storm event resulted in water overtopping the left training wall and flooding the mill parking lot.

(3) The ungated spillway capacity with the water surface at the top of the dam (Elevation 387.10 feet) was estimated to be 5,300 cfs.

(4) The ungated spillway capacity with the water surface at the test flood elevation (Elevation 389.2 feet) was estimated to be 8,510 cfs.

(5) Gated spillway capacity at normal pool elevation - N/A

(6) Gated spillway capacity at test flood elevation - N/A

(7) The total spillway capacity at the test flood elevation (Elevation 389.2 feet) was estimated to be 8,510 cfs.

(8) The total project discharge at the top of the dam (Elevation 387.10 feet) was estimated to be 5,300 cfs.

(9) The total project discharge at the test flood elevation (Elevation 389.2 feet) was estimated to be 9,140 cfs.

c. Elevation (Feet NGVD) based on an elevation of 390.64, which is the elevation of TBM #13 located on a granite stone on top of the right training wall approximately 10 feet upstream from the spillway. This TBM was established for the survey work associated with preparation of the Flood Plain Insurance Study for Winchester, New Hampshire and is referenced to the National Geodetic Vertical Datum of 1929 (NGVD).

(1) Streambed at toe of dam - 370

(2) Bottom of cutoff - unknown

(3) Maximum tailwater - unknown

(4) Normal pool - 382

(5) Full flood control pool - N/A

(6) Spillway crest - elevation varies
(a) low flow spillway - 380.46
(b) overflow section - 381.4 (min), 382.54 (max)

(7) Design surcharge (Original Design) - unknown

(8) Top of dam - elevation varies
(a) left training wall - 387.10 (max)
(b) right training wall
concrete face - 388.01 (max)
stone masonry structure - 390.64 (max)

(9) Test flood surcharge - 389.2

d. Reservoir (Length in feet)

(1) Normal pool - 2,500

(2) Flood control pool - N/A

(3) Spillway crest pool - 2,200 (crest of low flow spillway)

(4) Top of dam - 3,500 (top of left training wall)

(5) Test flood pool - 3,900

e. Storage (acre-feet)

(1) Normal pool - 63

(2) Flood control pool - N/A

(3) Spillway crest pool - 50 (crest of low flow spillway)

(4) Top of dam - 112 (top of left training wall)

(5) Test flood pool - 135

f. Reservoir Surface (acres)

(1) Normal pool - 8.6

(2) Flood control pool - N/A

(3) Spillway crest - 8 (crest of low flow spillway)

(4) Top of dam - 10.8 (top of left training wall)

(5) Test flood pool - 11.6

g. Dam

(1) Type - rock-filled, timber crib gravity overflow structure with a concrete cap

(2) Length - 101 feet (overflow section)
150 feet (overall)

(3) Height - 12 feet (overflow section, max)
17 feet (top of left training wall)

(4) Top width - N/A

(5) Side Slopes - overflow section-upstream slope, 1V to 2.6H; downstream slope, 1V to 2.6H

(6) Zoning - unknown

(7) Impervious Core - unknown

(8) Cutoff - unknown

(9) Grout curtain - none

(10) Other - none

h. Diversion and Regulating Tunnel

Not Applicable

i. Spillway

(1) Type - concrete capped overflow section, with low flow spillway

(2) Length of weir - 101 feet (total length of overflow section
35 feet (length of low flow spillway)

(3) Crest elevation - elevation varies
(a) low flow spillway - 380.46
(b) Remainder of overflow section - 381.4 (min), 382.54 (max)

(4) Gates - N/A

(5) U/S Channel - The slopes of the river channel upstream from the dam appear to be stable, although some boulders have been dumped in front of the waste gates which are located in the right training wall about 30 feet upstream from the low flow spillway. Trees are growing on both banks of the river, but the channel is generally wide and unobstructed. A small access bridge to the mill site spans the river approximately 750 feet upstream from the dam.

(6) D/S Channel - The overflow section discharges into a natural river channel below the dam. The bottom of the downstream channel is covered with cobbles and boulders. Trees overhang both banks of the downstream channel, and various sections of the mill complex are located along the left bank of the channel. In general, the channel is wide and unobstructed except for a few logs in the channel and along the right bank of the channel.

j. Regulating Outlets - There are no operating regulating outlets since the waste gates have been blocked with boulders and the penstock used to intake process water does not discharge to the river downstream from the dam. Apparently, four gates originally existed, but only two of these were observed during the inspection. The following information is based on the inspection of those two gates.

(1) Invert - Waste gates - 377±

(2) Size - Waste gates - 4 feet by 4 feet

(3) Description - Waste gates - 4 feet by 4 feet opening passing through stone masonry section adjacent to right abutment. Gates were apparently constructed of wood.

(4) Control Mechanism - Waste gates - missing.

SECTION 2
ENGINEERING DATA

2.1 Design

No design data were found for the Robertson Dam

2.2 Construction

No construction records were found.

2.3 Operation

No engineering operational data were found.

2.4 Evaluation

a. Availability. No engineering data were available for the Robertson Dam. A search of the files of the New Hampshire Water Resources Board and direct contact with the owner, revealed a limited amount of recorded information.

b. Adequacy. The lack of in-depth engineering data did not allow for a definitive review. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing design and construction data, but is based primarily on visual inspection, past performance history and sound engineering judgment.

c. Validity. No engineerng data were found to validate.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General. Robertson Dam is a run-of-river dam and, consequently, impounds a pool of small size. The drainage area is quite large, consisting of hilly and mountainous terrain surrounding numerous lakes, ponds and swampy areas which eventually drain to the dam. There are a number of small dams located on the lakes and ponds in the watershed, as well as two Corps of Engineers flood control dams. The majority of the drainage basin is heavily wooded. Development in the drainage basin is quite variable ranging from large sections of undeveloped land to more extensively developed portions around towns and tourist areas. The river channel downstream from the dam is generally undeveloped except for the mill buildings located immediately below the dam on the left channel bank (See Photo No. 2).

The field inspection of Robertson Dam was made on June 17, 1980. The inspection team consisted of personnel from S E A Consultants Inc. and Geotechnical Engineers Inc. Inspection checklists completed during the visual inspection are included in Appendix A. At the time of inspection, water was passing approximately 15 inches deep over the crest of the low flow spillway. Water was also passing approximately 3 to 4 inches deep over a portion of the overflow section near the left abutment where the crest has apparently settled. The pool elevation was at approximately 381.7 feet NGVD. The upstream face of the dam could only be inspected above this water level. Due to the discharge of water over the dam and tailwater against the downstream toe of the dam, it was not possible to adequately inspect the downstream face.

b. Dam. Robertson Dam is a run-of-river dam consisting of a rock-filled timber crib overflow section capped with a 10-inch thick concrete slab (See Photos Nos. 6 and 7). The overall length of the dam is 150 feet, with a maximum height of about 17 feet. The overflow section is about 101 feet long between training walls and approximately 12 feet high from downstream channel bottom to top of permanent crest. Located adjacent to the right training wall is a 35 feet long by 1.8 feet deep low flow spillway cast into the concrete slab capping the overflow section. At the left side of the crest of the low flow spillway, there is a cavity about 9 inches deep where a section of the concrete cap has apparently broken free (See Photo No. 8).

The elevation of the crest of the overflow section between the low flow spillway and the left training wall varies by over one foot. Since there were no major cracks observed in the concrete cap, it appears that this settlement occurred in the rock filled timber crib structure some time before the concrete cap was added.

The left training wall is constructed of concrete. There is considerable vegetation on the left abutment immediately upstream of the left training wall. Crushed stone has been dumped on the left abutment immediately behind the left training wall. The downstream face of the left abutment consists of soil which is essentially bare of vegetation and unprotected against erosion except where large rocks and excess concrete have been randomly dumped. The remainder of the left abutment starting at a point about 20 feet behind the left training wall is a paved parking lot.

There is a major discharge of water from the left bank of the downstream channel at the toe of the dam (See Photo No. 5). The discharging water has a grayish, turbid appearance and contains many bits of paper. There is no evidence of a discharge pipe, but the character of the discharging water indicates that it is probably coming from processing operations in the paper plant that is located at the left abutment.

The right training wall is constructed of dry cut stone masonry partially faced with concrete. There are two major vertical cracks in the concrete facing (See Photos Nos. 4 and 9). The stone masonry section is parallel to the river and is at least 72 feet long, varies in thickness from 8.0 to 10.0 feet and in height from 14.0 to 20.0 feet. It was not possible to determine from the visual inspection alone whether the right training wall consisted of stone masonry throughout its thickness or if it consisted of earthfill between two stone face walls. Sketches attached to two inspection reports dating from the 1930's imply that the right training wall is solid masonry. There is at least some quantity of earthfill along the crest of the right training wall with weeds, brush and small trees growing on the earthfill (See Photos No. 3, 4 and 9).

There are some large trees and brush growing from the back of the stone masonry section of the right training wall (See Photo No. 11). There is a major leakage at the base of the right training wall near the abutment.

c. Appurtenant Structures. Located in the stone masonry section of the right training wall are a series of waste gates. Two gates were observed during the inspection (See Photo No. 12). These gates have been blocked with stone rubble dumped on the upstream face of the right training wall and are inoperable. A small amount of leakage was emanating from the two gates at the time of inspection. Located on the crest of the stone masonry section of the right training wall directly above the waste gates are three wooden beams. These are apparently all that remain of a gate house referred to in several inspection reports from the 1930's.

Located approximately 50 feet upstream from the left training wall is the intake for a penstock which supplies process water to the adjoining mill. There is no gate on the process water penstock, so flow is controlled with long planks placed on the upstream face of the penstock intake structure to either partially or completely block the inlet.

d. Reservoir Area. The slopes of the river channel upstream from the dam appear to be stable. Trees are growing on both banks of the river, but the channel is generally wide and unobstructed. A small access bridge to the mill site spans the river approximately 750 feet upstream from the dam (See Photo No. 1).

e. Downstream Channel. The overflow section discharges into a natural river channel below the dam. The bottom of the downstream channel is covered with cobbles and boulders. Trees overhang both banks of the downstream channel and various sections of the mill complex are located along the left bank of the channel (See Photo No. 2). In general, the channel is wide and unobstructed.

There are two dams located on the Ashuelot River downstream of Robertson Dam. The first dam is about 0.7 miles below Robertson Dam and the second dam is about 1.0 miles further downstream. Starting just below the second dam and continuing for about one mile, the village of Hinsdale is located adjacent to the river channel. The confluence with the Connecticut River is about 3.6 miles downstream of Robertson Dam.

3.2 Evaluation

On the basis of the visual inspection, Robertson Dam is considered to be in poor condition.

Major leakage at the base of the stone masonry section of the right training wall near the abutment could result in a failure of the right abutment, if not controlled.

Two major vertical cracks in the concrete facing at the right training wall could be signs of serious structural instability of this training wall.

Large trees and brush growing from the back face of the stone masonry section of the right training wall and small trees and brush growing on the earthfill along the crest of the right training wall could cause seepage and erosion problems if a tree blows over and pulls out its roots, or if a tree dies or is cut and its roots rot.

The settlement that has occurred in the crest of the overflow section between the low flow spillway and the left trainng wall could be an indication of continuing structural deterioration of the rock-filled timber crib structure. The section of the concrete cap that has broken free at the left side of the crest of the low flow spillway could lead to continued erosion of the concrete cap and a progressive lowering of the crest.

A major discharge of water from the left bank of the downstream channel at the toe of the dam could cause internal erosion and failure of the soil abutment at the left end of the dam. The lack of surface erosion protection on the bare soil on the downstream face of the left abutment makes that abutment susceptible to erosion if the dam should be overtopped.

The lack of an operating low level outlet is a deficiency which would not allow the ponding area upstream from the dam to be lowered below the low-flow spillway crest.

SECTION 4
OPERATIONAL AND MAINTENANCE PROCEDURES

4.1 Operational Procedures

a. General. Robertson Dam is used primarily to impound water from the Ashuelot River for industrial purposes. There are no written or routine operational procedures since there are no functional operating facilities incorporated into the dam.

b. Description of Any Warning System in Effect. No written warning system exists for the dam.

4.2 Maintenance Procedures

a. General. The owner, Paper Service Mills, is responsible for the maintenance of the dam. No formal or written maintenance plan exists.

b. Operating Facilities. There are no functional operating facilities incorporated into the dam.

4.3 Evaluation

The current maintenance procedures for Robertson Dam are inadequate to insure that all problems encountered can be remedied within a reasonable period of time. The owner should establish a written maintenance procedure, as well as establish a warning system to follow in event of flood flow conditions or imminent dam failure.

SECTION 5
EVALUATION OF HYDROLOGIC/HYDRUALIC FEATURES

5.1 General. Robertson Dam is a run-of-river dam consisting of a rock-filled timber crib overflow section capped with a 10-inch thick concrete slab. The overall length of the dam is 150 feet, with a height of about 17 feet. The overflow section is about 101 feet long between training walls and approximately 12 feet high from downstream channel bottom to top of permanent crest. Located adjacent to the right training wall is a 35 feet long by 1.8 feet deep low flow spillway cast into the concrete slab capping the overflow section. A penstock which intakes water to the mill is located approximately 50 feet upstream from the left abutment. Water entering the penstock is used as process water for the mill and is eventually passed on to the mill's wastewater treatment facility. Located in the stone masonry portion of the dam near the right abutment are a series of waste gates. Two gates were observed during the inspection. However, records on file at the New Hampshire Water Resources Board indicate that originally four gates existed. The two observed gates have been blocked with stone rubble and are inoperable. A small amount of leakage was emanating from the two gates at the time of inspection.

The drainage area above Robertson Dam is quite large, consisting of hilly and mountainous terrain surrounding numerous lakes, ponds, and swampy areas which eventually drain to the dam. There are a number of small dams located in the drainage basin, as well as two Corps of Engineers flood control dams. The Robertson Dam is classified as small in size having a maximum storage of 112 acre-feet.

5.2 Design Data. No hydrological or hydraulic design data were disclosed.

5.3 Experience Data. Data relating to known flood discharges for the Ashuelot River are available from U.S. Geological Survey Gage No. 01-161-000 which is located in Hinsdale, New Hampshire approximately 2.4 miles downstream from the dam. Based on the gaging information, the maximum flood at the damsite would have occurred on March 19, 1936. The estimated discharge at the gaging station was 16,600 cfs. However, this flood occurred prior to the construction of two flood control dams (Surry Mountain Dam and Otter Brook Dam) which are located upstream from Robertson Dam, and prior to the reconstruction of Robertson Dam which occurred in the early 1970's. Since that time, discharges of 6,040 cfs and 6,010 cfs were recorded at the gaging station on December 12, 1973 and March 9, 1979, respectively. The owner reported that the latter storm event resulted in water overtopping the left training wall and flooding the mill parking lot.

5.4 Test Flood Analysis. Due to the absence of detailed design and operational information, the hydrologic evaluation was performed utilizing data gathered during field inspection, watershed size and an estimated test flood determined from information contained in the draft of the Flood Plain Insurance Study. For this dam (small size and significant hazard), the test flood ranges from a 100-year flood to one-half the Probable Maximum Flood (1/2 PMF). The 100-year flood was selected for this analysis since the dam falls near the lower end of the range of storages given for the small size classification. The water surface behind the dam was assumed to be at an elevation of 380.5 feet prior to the test flood routing.

Data from USGS Gage No. 01-161-000 were utilized to establish the peak discharge-frequency relationships for floods of selected recurrence intervals which were included in a Flood Plain Insurance Study available in draft form at the Boston office of the Federal Emergency Management Agency. Both the log-Pearson Type III analysis and the area ratio technique were utilized to estimate these peak discharge-frequency relationships, with appropriate consideration given to the two flood control dams that are located upstream from the Robertson Dam. The information contained in this report was used to determine the 100-year test flood inflow for the Robertson Dam.

The test flood inflow was estimated to be 9,150 cfs. The test flood was routed through the reservoir in accordance with the Corps of Engineers procedure for Estimating Effect of Surcharge Storage on Maximum Probable Discharge. The routed test flood outflow was estimated to be 9,140 cfs. This analysis indicated that the dam crest (top of the left training wall) would be overtopped by approximately 2.1 feet. The capacity of the overflow section with the water surface at the dam crest was estimated to be approximately 5,300 cfs, which is about 58 percent of the routed test flood outflow.

5.5 Dam Failure Analysis. The impact of dam failure was assessed utilizing the "Rule of Thumb" Guidance for Estimating Downstream Failure Hydrographs published by the Corps of Engineers. The analysis covered a reach extending approximately 0.7 miles downstream to the Ashuelot River Dam. The prefailure discharge with the water surface at the dam crest is significant, so prefailure tailwater conditions were included in the hydrologic calculations and the dam failure analysis was conducted with the water surface at the dam crest. Under these conditions, it was determined that the routed dam failure discharge would significantly increase the hazard over the prefailure discharge tailwater.

Due to the general condition of the stone masonry portion of the dam adjacent to the right abutment, it was determined that this section of the dam represented the most probable place for an assumed breach to occur. Consequently, a total of 60 feet of the dam adjacent to the right abutment was breached with a failure height of about 17 feet. The total failure discharge was estimated to be 11,100 cfs, which included a discharge of 7,130 cfs through the breached section plus discharge over the unfailed portion of the spillway. The spillway discharge immediately prior to failure was estimated to be 5,300 cfs.

Discharge resulting from an assumed failure of the dam would cause an increase in stage of about 3 to 4 feet above the downstream prefailure tailwater. This increase in stage would cause water to rise about 2 to 3 feet above the sill of portions of the mill buildings located adjacent to the river channel. The potential for economic loss as well as for the loss of less than a few lives would exist. The nearest potential hazard beyond the mill at the Robertson Dam is the Ashuelot River Dam located at the Ashuelot Paper Company about 0.7 miles downstream. By the time the failure discharge reaches this dam, the failure stage would be significantly reduced due to the available storage along the channel. Based on this analysis, the Robertson Dam has been classified as a significant hazard.

SECTION 6
EVALUATION OF STRUCTURAL STABILITY

6.1 Visual Observations

The visual inspection indicates the following potential structural problems:

(1) Major leakage at the base of the stone masonry section of the right training wall near the abutment which could cause internal erosion and failure of the abutment.

(2) Two major vertical cracks in the concrete facing at the right training wall could be signs of serious structural instability of this training wall.

(3) Large trees and brush growing from the back face of the stone masonry section of the right training wall and small trees and brush growing on the earthfill along the crest of the right training wall could cause seepage and erosion problems if a tree blows over and pulls out its roots, or if a tree dies or is cut and its roots rot.

(4) The settlement that has occurred in the crest of the overflow section between the low flow spillway and the left training wall could be an indication of continuing structural deterioration of the rock-filled timber crib structure.

(5) The section of the concrete cap that has broken free at the left side of the crest of the low flow spillway could lead to continued erosion of the concrete cap and a progressive lowering of the crest.

(6) Major discharge of water from the left bank of the downstream channel at the toe of the dam could cause internal erosion and failure of the soil abutment at the left end of the dam.

(7) The lack of surface erosion protection on the bare soil on the downstream face of the left abutment makes that abutment susceptible to erosion if the dam should be overtopped.

6.2 Design and Construction Data

No information regarding the design or construction of the original structure was found. From inspection reports, it can be determined that the original structure consisted of a 175 feet long plank-covered timber crib overflow section with 2 feet high flashboards constructed between the mill building on the left abutment and a stone masonry training wall at the right abutment. Two intake gates at the left abutment provided water to a turbine and a wheel to generate electricity. Four waste gates and a gate house were located at the right training wall.

6.3 Post-Construction Changes

Extensive repairs were made in 1927 and 1936, but the basic configuration of the dam remained unchanged. In the early 1970's extensive renovations were made changing the dam to its current configuration. Major changes included shortening of the overflow section by 75 feet and complete reconstruction of the left abutment, pouring a concrete cap over the timber crib overflow section and placement of stone rubble on the upstream face of the right training wall blocking the waste gates.

6.4 Seismic Stability

This dam is located in Seismic Zone 2 and, in accordance with the Phase I guidelines, does not warrant seismic analysis.

SECTION 7
ASSESSMENT, RECOMMENDATIONS, AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. The visual examination indicates that Robertson Dam is in poor condition. The major concerns with respect to the integrity of the dam are:

(1) Major leakage in the right abutment area.

(2) Two major vertical cracks in the concrete facing at the right training wall.

(3) Trees and brush growing along the crest and from the back face of the stone masonry section of the right training wall.

(4) Settlement in the crest of the overflow section.

(5) The section of concrete cap that has broken free at the left side of the crest of the low flow spillway.

(6) Major discharge of water from the left bank of the downstream channel at the toe of the dam.

(7) Lack of surface erosion protection on the downstream face of the left abutment.

The lack of an operating low level outlet that would allow drawdown of the pool below the low-flow spillway crest is considered to be a deficiency rather than a major concern.

b. Adequacy of Information. Due to the discharge of water over the dam and tailwater against the downstream toe of the dam, it was not possible to adequately inspect the downstream face or to determine whether leakage was occurring through and under the dam.

The information available from the visual inspection is adequate to identify the problems listed in 7.2. These problems require the attention of a qualified registered professional engineer who will have to make additional engineering studies to design or specify remedial measures. No other engineering studies are needed for the purpose of this Phase I inspection.

c. Urgency. The owner should implement the recommendations in 7.2 and 7.3 within one year after receipt of this Phase I report.

7.2 Recommendations

The owner should engage a registered professional engineer qualified in the design and construction of dams to:

(1) Investigate the leakage at the right abutment and design remedial measures.

(2) Design repairs for the two major vertical cracks in the concrete facing at the right training wall.

(3) Specify procedures for removal of trees and brush from the right training wall.

(4) Investigate the settlement in the crest of the overflow section and design remedial measures, if necessary.

(5) Investigate the discharge of water from the left bank of the downstream channel at the toe of the dam and design remedial measures, if necessary.

(6) Specify erosion protection for the downstream face of the left abutment.

(7) Perform a detailed hydrologic-hydraulic investigation to assess further the potential of overtopping the dam and the need for and the means to increase project discharge capacity.

(8) Assess the need for and means to provide a low level regulating outlet that would allow drawdown of the pool.

(9) Inspect the downstream face of the overflow section under no flow conditions.

The owner should carry out the recommendations made by the engineer.

7.3 Remedial Measures

a. Operating and Maintenance Procedures. The owner should:

(1) Repair all cracked and eroded concrete.

(2) Clear the trees and brush from the right abutment.

(3) Visually inspect the dam and appurtenant structures once a month.

(4) Engage a registered professional engineer qualified in the design and construction of dams to make a comprehensive technical inspection of the dam once every year.

(5) Establish a surveillance program for use during flood periods and also a downstream warning system to follow in case of emergency conditions.

(6) Establish a written maintenance procedure.

7.4 Alternatives

There are no practical alternatives to the recommendations of Sections 7.2 and 7.3

APPENDIX A
INSPECTION CHECKLIST

INSPECTION CHECK LIST
PARTY ORGANIZATION

PROJECT: Robertson Dam, NH

DATE: June 17, 1980

TIME: 10:00 a.m.

WEATHER: Sunny, cool

W.S. ELEV. 381.7 (NGVD) U.S. 372.3 DN.S.

PARTY:

1. Kenneth Stewart, S E A
2. Bruce Pierstorff, S E A
3. Robert Durfee, S E A
4. Philip Upton, S E A
5. Ronald Hirschfeld, GEI
6. Richard DeBold, NHWRB
7.
8.
9.
10.

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	Structural Stability	K. Stewart/R. Durfee	
2.	Hydrology/Hydraulics	B. Pierstorff	
3.	Soils and Geology	R. Hirschfeld	
4.			
5.			
6.			
7.			
8.			
9.			
10.			

INSPECTION CHECK LIST

PROJECT: Robertson Dam, NH DATE: June 17, 1980

PROJECT FEATURE: Dam Embankment NAME: _____

DISCIPLINE: _____ NAME: _____

AREA EVALUATED	CONDITIONS
DAM EMBANKMENT	
Crest Elevation	Varies; low flow spillway - 380.46; overflow section - 381.4 (min), 382.54 (max)
Current Pool Elevation	381.7
Maximum Impoundment to Date	Unknown
Surface Cracks	Two major vertical cracks in concrete facing of right training wall
Pavement Condition	Not paved
Movement or Settlement of Crest	Crest elevation of overflow section varies by more than one foot
Lateral Movement	None observed
Vertical Alignment	See "Movement or Settlement of Crest"
Horizontal Alignment	Good
Condition at Abutment and at Concrete Structures	Fair
Indications of Movement of Structural Items on Slopes	None observed
Trespassing on Slopes	None observed
Vegetation on Slopes	Brush and small trees on both abutment
Sloughing or Erosion of Slopes or Abutments	Minor erosion on downstream face of left abutment
Rock Slope Protection - Riprap Failures	No riprap
Unusual Movement or Cracking at or near Toe	None observed
Unusual Embankment or Downstream Seepage	Major leakage at base of right training wall and from the left bank of the downstream channel at the toe of the dam
Piping or Boils	None observed
Foundation Drainage Features	None
Toe Drains	None
Instrumentation System	None

INSPECTION CHECK LIST

PROJECT: Robertson Dam, NH DATE: June 17, 1980

PROJECT FEATURE: Dike Embankment NAME: _____

DISCIPLINE: _____ NAME: _____

AREA EVALUATED	CONDITIONS
DIKE EMBANKMENT	No Dike
Crest Elevation	
Current Pool Elevation	
Maximum Impoundment to Date	
Surface Cracks	
Pavement Condition	
Movement or Settlement of Crest	
Lateral Movement	
Vertical Alignment	
Horizontal Alignment	
Condition at Abutment and at Concrete Structures	
Indications of Movement of Structural Items on Slopes	
Trespassing on Slopes	
Vegetation on Slopes	
Sloughing or Erosion of Slopes or Abutments	
Rock Slope Protection - Riprap Failures	
Unusual Movement or Cracking at or near Toes	
Unusual Embankment or Downstream Seepage	
Piping or Boils	
Foundation Drainage Features	
Toe Drains	
Instrumentation System	

INSPECTION CHECK LIST

PROJECT: Robertson Dam, NH DATE: June 17, 1980

PROJECT FEATURE: Intake Channel NAME:

DISCIPLINE: NAME:

AREA EVALUATED	CONDITIONS
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	No outlet works
a. Approach Channel	
Slope Conditions	
Bottom Conditions	
Rock Slides or Falls	
Log Boom	
Debris	
Condition of Concrete Lining	
Drains or Weep Holes	
b. Intake Structure	
Condition of Concrete	
Stop Logs and Slots	

INSPECTION CHECK LIST

PROJECT: Robertson Dam, NH DATE: June 17, 1980

PROJECT FEATURE: Control Tower NAME: _____

DISCIPLINE: _____ NAME: _____

AREA EVALUATED	CONDITIONS
OUTLET WORKS - CONTROL TOWER	No control tower
a. Concrete and Structural	
General Condition	
Condition of Joints	
Spalling	
Visible Reinforcing	
Rusting or Staining of Concrete	
Any Seepage or Efflorescence	
Joint Alignment	
Unusual Seepage or Leaks in Gate Chamber	
Cracks	
Rusting or Corrosion of Steel	
b. Mechanical and Electrical	
Air Vents	
Float Wells	
Crane Hoist	
Elevator	
Hydraulic System	
Service Gates	
Emergency Gates	
Lightning Protection System	
Emergency Power System	
Wiring and Lighting System	

INSPECTION CHECK LIST

PROJECT: Robertson Dam, NH DATE: June 17, 1980

PROJECT FEATURE: Transition and Conduit NAME: _____

DISCIPLINE: _____ NAME: _____

AREA EVALUATED	CONDITIONS
OUTLET WORKS - TRANSITION AND CONDUIT	No outlet works
General Condition of Concrete	
Rust or Staining on Concrete	
Spalling	
Erosion or Cavitation	
Cracking	
Alignment of Monoliths	
Alignment of Joints	
Numbering of Monoliths	

INSPECTION CHECK LIST

PROJECT: Robertson Dam, NH DATE: June 17, 1980

PROJECT FEATURE: Outlet Structure NAME: _____

DISCIPLINE: _____ NAME: _____

AREA EVALUATED	CONDITIONS
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	No outlet works
General Condition of Concrete	
Rust or Staining	
Spalling	
Erosion or Cavitation	
Visible Reinforcing	
Any Seepage or Efflorescence	
Condition at Joints	
Drain holes	
Channel	
Loose Rock or Trees Overhanging Channel	
Condition of Discharge Channel	

INSPECTION CHECK LIST

PROJECT: Robertson Dam, NH DATE: June 17, 1980

PROJECT FEATURE: Spillway Weir NAME: _____

DISCIPLINE: _____ NAME: _____

AREA EVALUATED	CONDITIONS
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	
General Condition	Good
Loose Rock Overhanging Channel	None observed
Trees Overhanging Channel	Some trees overhanging channel
Floor of Approach Channel	Not visible beneath water surface
b. Weir and Training Walls	
General Condition of Concrete	Fair
Rust or Staining	None observed
Spalling	Two major vertical cracks in concrete facing of right training wall; section of concrete cap broken free at left side of crest of low flow spillway
Any Visible Reinforcing	None observed
Any Seepage or Efflorescence	Major leakage at base of right training wall
Drain Holes	None observed
c. Discharge Channel	
General Condition	Good
Loose Rock Overhanging Channel	None observed
Trees Overhanging Channel	Some trees overhanging channel
Floor of Channel	Cobbles and boulders
Other Obstructions	A few logs on banks and in channel

INSPECTION CHECK LIST

PROJECT: Robertson Dam, NH DATE: June 17, 1980

PROJECT FEATURE: Service Bridge NAME: _____

DISCIPLINE: _____ NAME: _____

AREA EVALUATED	CONDITIONS
OUTLET WORKS - SERVICE BRIDGE	No service bridge
a. Super Structure	
Bearings	
Anchor Bolts	
Bridge Seat	
Longitudinal Members	
Under Side of Deck	
Secondary Bracing	
Deck	
Drainage System	
Railings	
Expansion Joints	
Paint	
b. Abutment & Piers	
General Condition of Concrete	
Alignment of Abutment	
Approach to Bridge	
Condition of Seat & Backwall	

APPENDIX B

ENGINEERING DATA

AVAILABLE ENGINEERING DATA

No Engineering Data other than past inspection reports from the State of New Hampshire Water Resource Board were available.

PAST INSPECTION REPORTS

State of New Hampshire

WATER RESOURCES BOARD

37 Pleasant Street

Concord, N.H. 03301

TELEPHONE 271-3406

September 25, 1978

Paper Service Mills
Russell E. O'Neal
Hinsdale, NH 03451

Dear Mr. O'Neal;

Under the provisions of RSA Chapter 482, Sections 8 through 15, the New Hampshire Water Resources Board is authorized to inspect all dams in the State which by reason of their physical condition, height and location may be a menace to the public safety.

The dam structure (No. 255.02) located on the Ashvelot River in Hinsdale was inspected on September 22, 1978 and as a result of this inspection, certain discrepancies were found which should require corrective measures in order to protect the integrity of the structure. (See attached sheet.)

Your dam has been classified by the Board as a non-menace dam and with this classification, the State will not insist that the item(s) noted on the attached be corrected, but it is advisable that corrective measures be voluntarily initiated to protect the integrity of the structure.

Should you make the repairs and/or maintenance items on the attached sheet in the waters of the State, you will need a permit from the Special Board. Applications can be obtained by writing or calling the Special Board Office, 37 Pleasant Street, Concord, New Hampshire 03301, telephone no. 271-2147.

Please feel free to call or write if you have any questions regarding the evaluation of your structure.

Sincerely,

CBM:paf
Enc.

George M. McGee, Sr.,
Chairman

cc:

1. The dam shows evidence of numerous leaks through the old timber crib. The two most severe areas are at the extreme left and of the spillway and at the junction of the low water and highwater spillway. These leaks should be stopped.

2. The discharge capacity of this structure has been reduced considerably. Our records show that the spillway used to extend through the present paved parking area to the mill building and had a spillway length of 175 feet. The estimated discharge capacity of that structure was about 7,700 cubic feet per second. The new concrete spillway is 85 feet long and has an estimated discharge capacity of 4,280 cubic feet per second. There is a stream gaging station on the Ashvelot River in Hinsdale which has furnished data with which an expected 100 year frequency flood can be predicted. This 100 flow is estimated at 8,600 cubic feet per second. TWICE THE CAPACITY OF YOUR STRUCTURE. On four occasions flows recorded exceeded the capacity of your strucutre. These flows occurred after the construction of the Surrey Mountain Resevoir. 1960 - 8,800 cubic feet per seconds; 4/62 - 5,090 cubic feet per second; and 12/73 - 6,040 cubic feet per second, and 3/73 - 5,880 cubic feet per second. The purpose of the previous data is to support the opinion of this board, that during a 100 year storm the abutments will be overtopped and you will probably sustain damage to the parking lot and adjacent mill buildings.

   In order to alleviate the potential risk it would be necessary to either raise the abutment, lower the spillway crest, or lengthen the spillway back to its original configuration.

Because this is a non-menace structure, which course of action or in-action is your choice. You now know what can be expected.

I hope we have been of assistance.

bhl

9/25/78

NEW HAMPSHIRE WATER RESOURCES BOARD

INSPECTION REPORT

Town: WINCHESTER Dam Number: 255.02

Name of Dam, Stream and/or Water Body: ASHUELOT

Owner: PAPER SERVICE MILLS Telephone Number: 336 5311

Mailing Address: RUSSELL ~~[illegible]~~ E. ONEAL HINSDALE NH

Max. Height of Dam: 21 TO TOP OF ABUT Pond Area: _____ Length of Dam: 90'

FOUNDATION: EARTH ?

OUTLET WORKS: 8.5' x 35' LOW WATER SPILLWAY
5' x 50' ADDITIONAL HIGHWATER SPILLWAY
85' TOTAL

ABUTMENTS: RT - CUT STONE W/ CONCRETE FACING
LT CONCRETE WATER MARK 2.3" BELOW TOP
~~RT EARTH~~ WAS RECENTLY OVERTOPPED

EMBANKMENT: RT - EARTH
LT - EARTH W/ ASPH PAVING & CONCRETE

Note: Give Sizing, Condition and detailed description for each item, if applicable.

SPILLWAY: Length: 85' Freeboard: 5'

SEEPAGE: Location, estimated quantity, etc.

SEE * ON PLAN VIEW

SUBSTANTIAL QUANTITIES

Changes Since Construction or Last Inspection:

SPILLWAY LENGTH REDUCED FROM 175' TO 85'

CONCRETE CAP OVER OLD TIMBER CRIB

CONCRETE DUMPED ON U/S SIDE TO REDUCE LEAKAGE

Tail Water Conditions:

FREE FLOWING

Overall Condition of Dam: FAIR

Contact With Owner: YES

Date of Inspection: 9/22/78 Suggested Reinspection Date _____

Class of Dam: NON-MENACE

Signature Kenneth Stern

Date 9/22/78

Note: Give Sizing, Condition and detailed description for each item, if applicable.

Dam No. 255.02

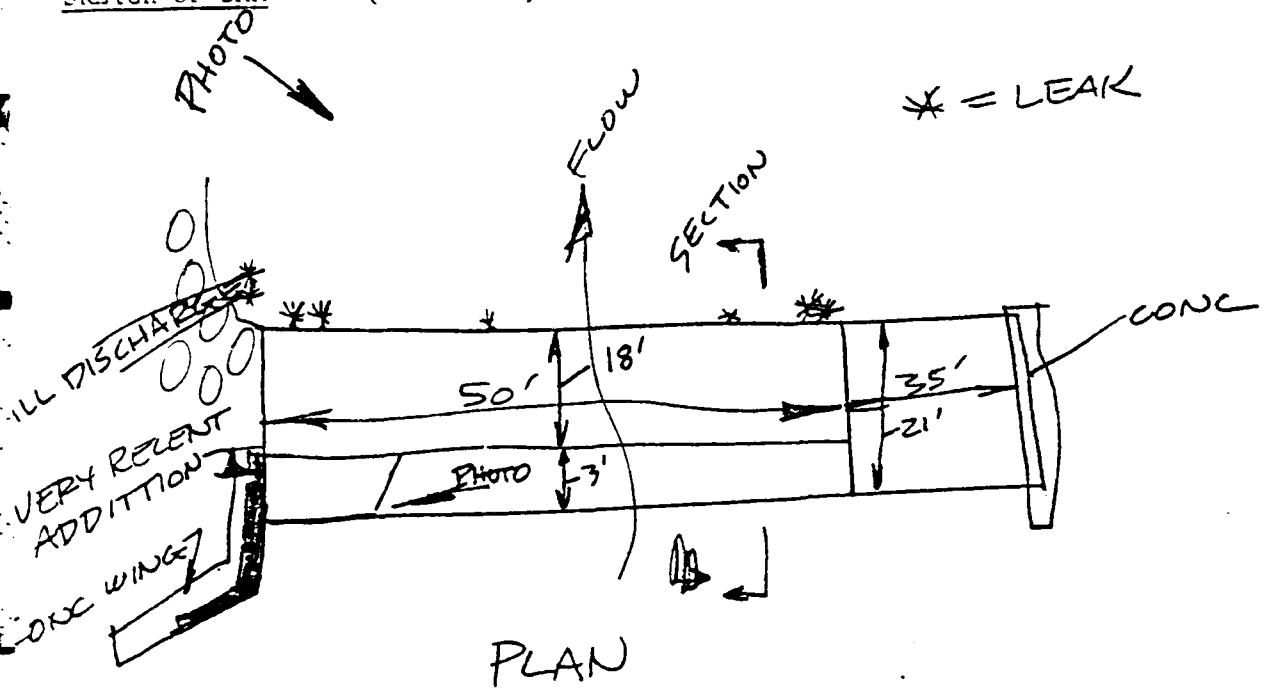
COMMENTS:

(1) NUMEROUS LEAKS

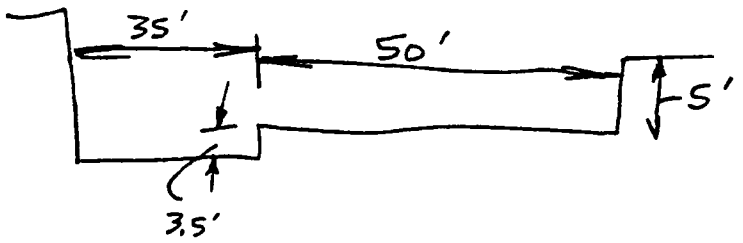
(2) SPILLWAY SHORTENED

Dam No. 255.02

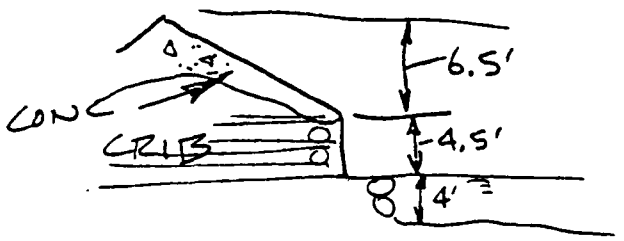
SKETCH OF DAM (Show Plan, Elevation & Cross Sections)



PLAN



SPILLWAY ELEVATION



SECTION

NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON DAMS IN NEW HAMPSHIRE

LOCATION STATE NO. 255.02

Town Winchester : County Cheshire

Stream Ashuelot R.

Basin-Primary Conn.R. : Secondary Ashuelot R.

Local Name Robertson Dam

Coordinates—Lat. : Long.

GENERAL DATA

Drainage area: Controlled Sq. Mi.: Uncontrolled Sq. Mi.: Total 406 Sq. Mi.

Overall length of dam 210 ft.: Date of Construction repaire in 1927 & again in 1936

Height: Stream bed to highest elev. 18 ft.: Max. Structure 14 ft.

Cost—Dam repairs in 1927 $20,000 : Reservoir

DESCRIPTION Timber crib stone abutments and gate structure

Waste Gates

Type stone

Number 4 : Size 5 ft. high x 3 ft. wide

Elevation Invert : Total Area sq. ft.

Hoist

Waste Gates Conduit

Number : Materials

Size ft.: Length ft.: Area sq. ft.

Embankment

Type

Height—Max. ft.: Min. ft.

Top—Width : Elev. ft.

Slopes—Upstream on: Downstream on

Length—Right of Spillway : Left of Spillway

Spillway

Materials of Construction Timber

Length—Total 175 ft.: Net ft.

Height of permanent section—Max. 14 ft.: Min. 12 ft.

Flashboards—Type : Height 2.5 ft.

Elevation—Permanent Crest 383.6 : Top of Flashboard

Flood Capacity cfs.: cfs/sq. mi.

Abutments

Materials: stone

Freeboard: Max. stone 6 ft.: Min. 4 ft.

Headworks to Power Devel.—(See "Data on Power Development")

OWNER Public Service Co., of N.H. Leased by Robertson Bros. Paper Co.

REMARKS condition fair
Use-Industrial

Tabulation By RLT Date 9/27/39

B&B21234

7206

NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON WATER POWER DEVELOPMENTS IN NEW HAMPSHIRE

LOCATION AT DAM NO. 255.02

Town Winchester : County Cheshire

Str m Ashuelot River

Basin-Primary Conn.R. : Secondary Ashuelot

Local Name Robertson Dam

GENERAL DATA

Head-Max. 12 ft.: Min. ..... ft.: Ave. ..... ft.

Date of Construction re-1927&1936 : Use of Power Industrial

Pondage ..... ac. ft.: Storage ..... ac. ft.

DESCRIPTION

Racks

Size of Rack Opening .....

Size of Bar ..... : Material .....

Area: Gross ..... Sq. Ft.: Net ..... sq. ft.

Head Gates

Type intake 'rack

Number ..... : Size ..... ft. high x ..... ft. wide

Elevation of Invert ..... : Total Area ..... sq. ft.

Hoist .....

Penstock

Number 1 : Material ?

Size ..... : Length .....

Turbines

Number 2 : Makers 27"Chase vertical.42"Rodney Hunt Horiz.

Rating HP. per unit 1,75HP.1,125HP : Total Capacity ..... HP.

Max. Dement C.F.S., per unit ..... : Total ..... cfs.

Drive

Type .....

Generator

Number .....

Make .....

Rating KW., per unit ..... ; Total Capacity ..... K. W.

Exciter

Number ..... : Make .....

Rating-per unit ..... : Total Capacity ..... K. W.

OUTPUT—KWHRS

19.....	.....	19.....	.....
19.....	.....	19.....	.....
19.....	.....	19.....	.....
19.....	.....	19.....	.....
19.....	.....	19.....	.....

OWNER Public Service of NH.Leased by Robertson Bros. Paper Co

Tabulation By9 RLT. Date 9/27/39

NEW HAMPSHIRE WATER RESOURCES BOARD

INVENTORY OF DAMS AND WATER POWER DEVELOPMENTS

DAM

BASIN Connecticut NO. 255.02 [425 acc
RIVER Ashuelot MILES FROM MOUTH 4.3 D.A.SQ.MI [406. ac
TOWN [illegible] OWNER Public Service Co. of N.H.
LOCAL NAME OF DAM [illegible]
BUILT _____ DESCRIPTION Timber dam (Robertson Bros Paper Co lessee)
repaired 1936 [illegible] PSC [illegible]
Timber crib Stone abutments & gate structure
POND AREA-ACRES _____ DRAWDOWN FT. _____ POND CAPACITY-ACRE FT. _____
HEIGHT-TOP TO BED OF STREAM-FT. 12 + 18 MAX. _____ MIN. _____
OVERALL LENGTH OF DAM-FT. 2[illegible] MAX.FLOOD HEIGHT ABOVE CREST-FT. _____
PERMANENT CREST ELEV.U.S.G.S. 363.6 LOCAL GAGE _____
TAILWATER ELEV.U.S.G.S. 371.15 Side LOCAL GAGE _____
SPILLWAY LENGTHS-FT. 150 ± [illegible] 175 wier FREEBOARD-FT. 4.0 ft 6. 12 ft
FLASHBOARDS-TYPE, HEIGHT ABOVE CREST [illegible] 2.5
WASTE GATES-NO. WIDTH MAX.OPENING DEPTH SILL BELOW CREST

REMARKS May High water 377.57 Toe of dam El. 372.2
21 Condition Fair

POWER DEVELOPMENT

UNITS NO.	RATED HP	HEAD FEET	C.F.S. FULL GATE	KW	MAKE
1	450	15.0	A [illegible]		
2	245	12 / 18	PSC		40") PSC
1	75	12		27	"Chase turbine vertical
1	125	12			42" Rodney Hunt [illegible]

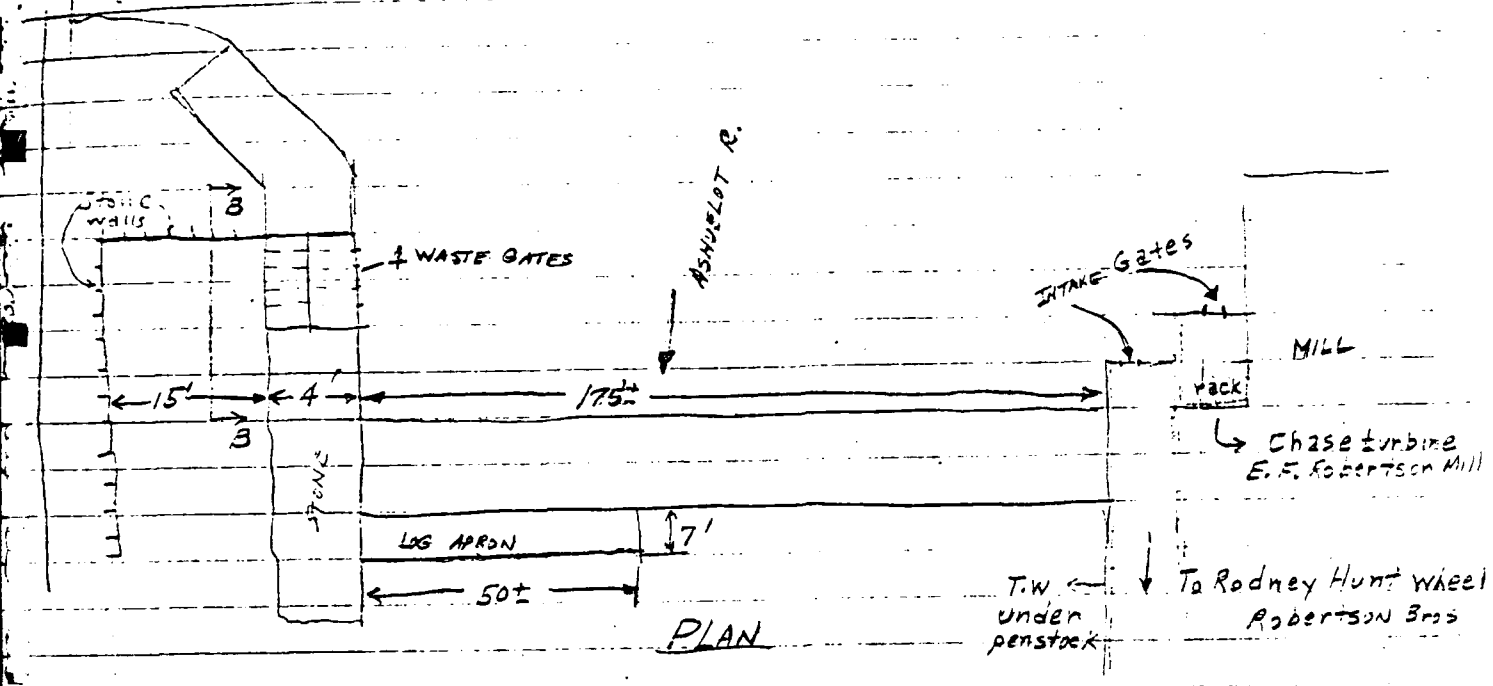
USE _____

REMARKS Short canal to Mill on S side Prop [illegible] on N side
Dam [illegible] Page [illegible] 120.6 Talked to C.B. O'Neil owner (PS Co owns land, buildings & dam) Formerly Chase turbine was in E.C. Robertson plant & Rodney Hunt in Robertson Bros. plant. O'Neil operates both mills as one unit. All three Robertson dams were bought by Insul and now belong to P.S. Co. of N.H.

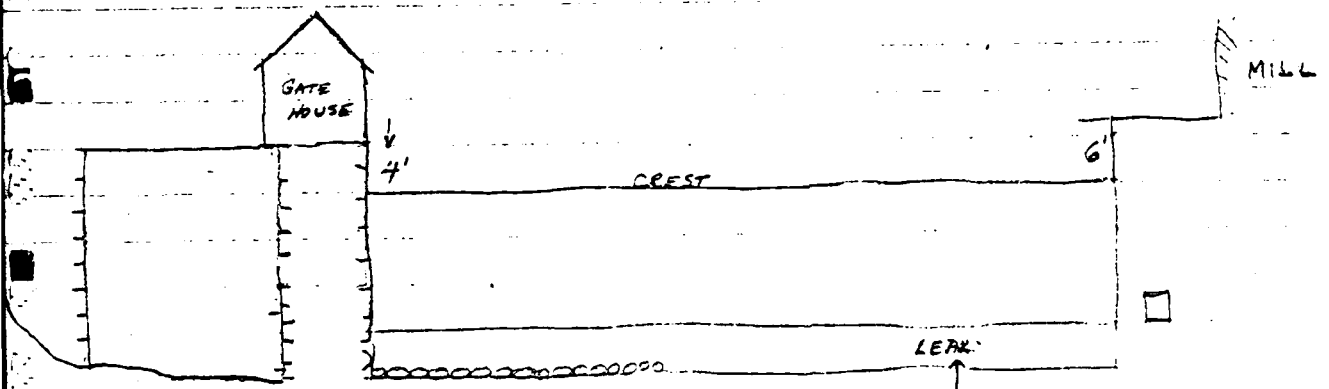
DATE 1937 [illegible]
10/20/37 [illegible]

P.S.N.H. DAM — WINCHESTER 10/20/37

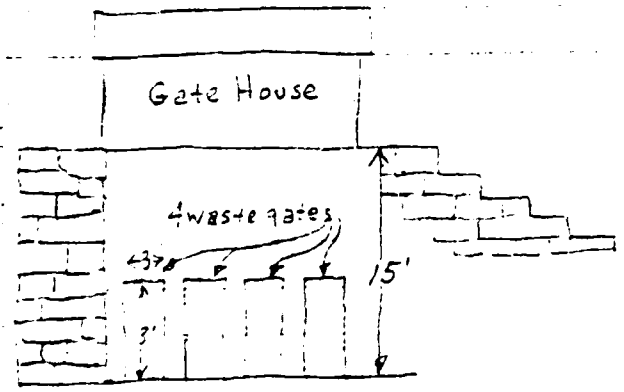
Robertson Bros. Paper Co /essee 255.02



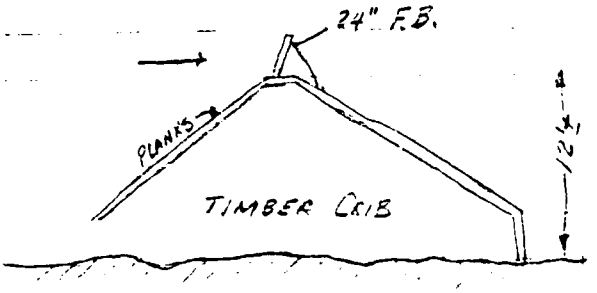
PLAN



PROFILE



Section E-E.



X-SECTION

State of New Hampshire
PUBLIC SERVICE COMMISSION

C O P Y

255.02

April 24, 1936

The Robertson Company
Hinsdale
New Hampshire

Dear Sirs:

We have at hand a report dated April 20, 1936, as follows:

"Dams considerably damaged."

Assuming that you plan to reconstruct, we are calling your attention to Chapter 215 of the Public Laws, Sections 13 to 20 inclusive (copy enclosed). We are also enclosing a Questionnaire-Statement. Please fill out and return the Statement to the Commission before beginning reconstruction.

Very truly yours,

N. H. PUBLIC SERVICE COMMISSION

Samuel J. Lord
Hyd. Eng.

SJL:V

enc.

Winchester

Inspected June 20, 1930.

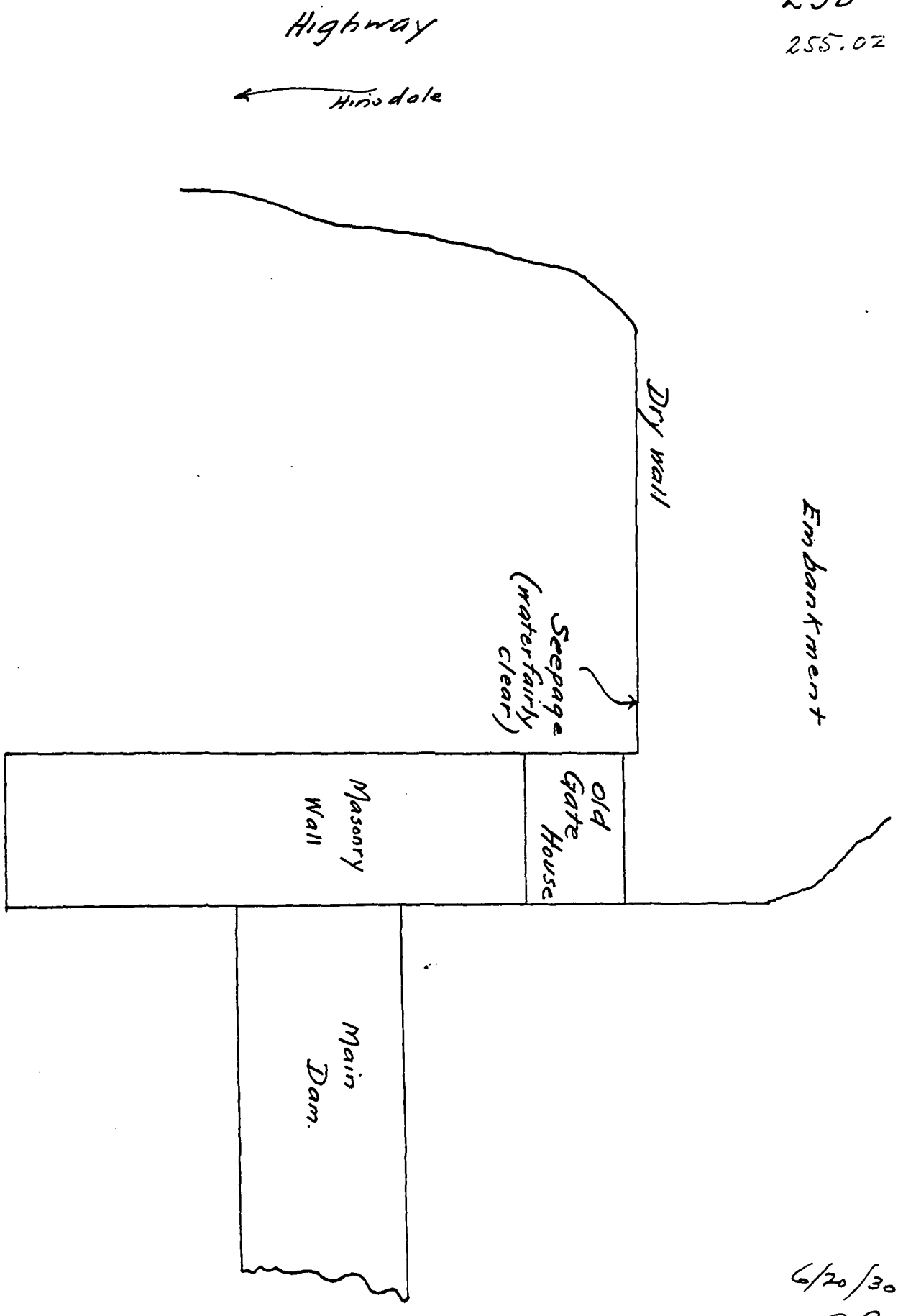
The Robertson Company
Robertson Brothers Division

The dam owned by the Public Service Company of New Hampshire develops about 280 horse power. This is an old timber crib dam with fourteen foot head which has been completely rebuilt in 1927, approximate expenditure, twenty-thousand dollars. New concrete on the west bank for inlet gates. At the site of an old gate house on the east bank, there is a dry stone wall on the downstream side of an earth filled dam which shows considerable seepage in the corner. This should be stopped. The penstock leaks quite badly and there is also a boil in the yard due to a leak in the flume. They have tried to stop this but have not been successful. Despite the fact that considerable repairs have been spent in 1927, it would seem that this dam is not in as good condition, expecially on the east bank, as it should be. Figure illustrates point of seepage.

DIVI-30.

29b

255.02



6/20/30

The Robertson Co
Robertson Bros Dir

File No. Washington 13

Field N. H. 1104.

DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

REPORT ON DEVELOPED WATER POWER

1. Name of stream on which power is located--Ashuelot River----------

2. Location of plant:-------¼ Sec.----------, T.--------, R.----------

Town or City---Winchester----------, County Cheshire, State N. H.

3. Location of point of diversion About 2 miles east of Hinsdale village

---

4. Name and address of owner or operator-Robertson Bros. Paper Mill--

---Hinsdale, N. H.----------

5. Operating head, fore bay to tailrace 12 & 18 ------feet. (see below)

6. Water wheels:

Head	No.	Kind	Make	Size	Rated capacity, horsepower (total)
12	----1----	----------	Chase	--48"----	----------
18	----1----	---------	Rodney Hunt	--42"----	----------
	---------	---------	-------	---------	----------
	---------	---------	-------	Total---	-------245----------

7. How many and what wheels are operated during the low-water season?

---Varies----------

8. What is the ordinary length of such low-water season?---3 months--

9. Generators: No.--None---- Total rated capacity (KVA)----------

10. Use of power-------Paper mill----------

11. Average number of hours per day plant runs--24----------

12. Auxiliary power---425 H. P. steam----------

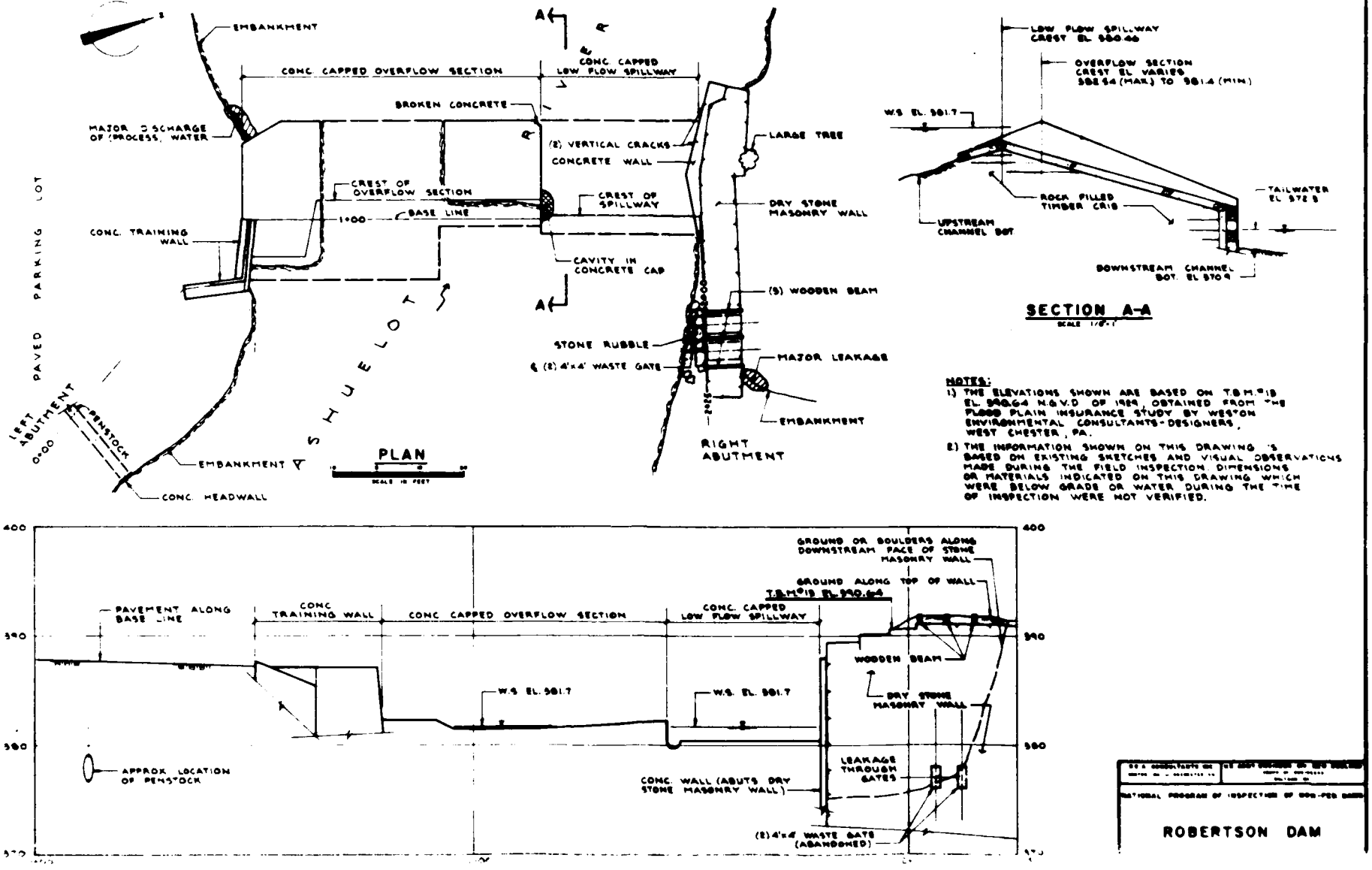
13. Storage reservoirs in addition to storage at dam-several small ones.

Number---------- Total capacity--Unknown----------

14. Date--June 8, 1919------ Prepared by---B. L. Bigwood.----------

13

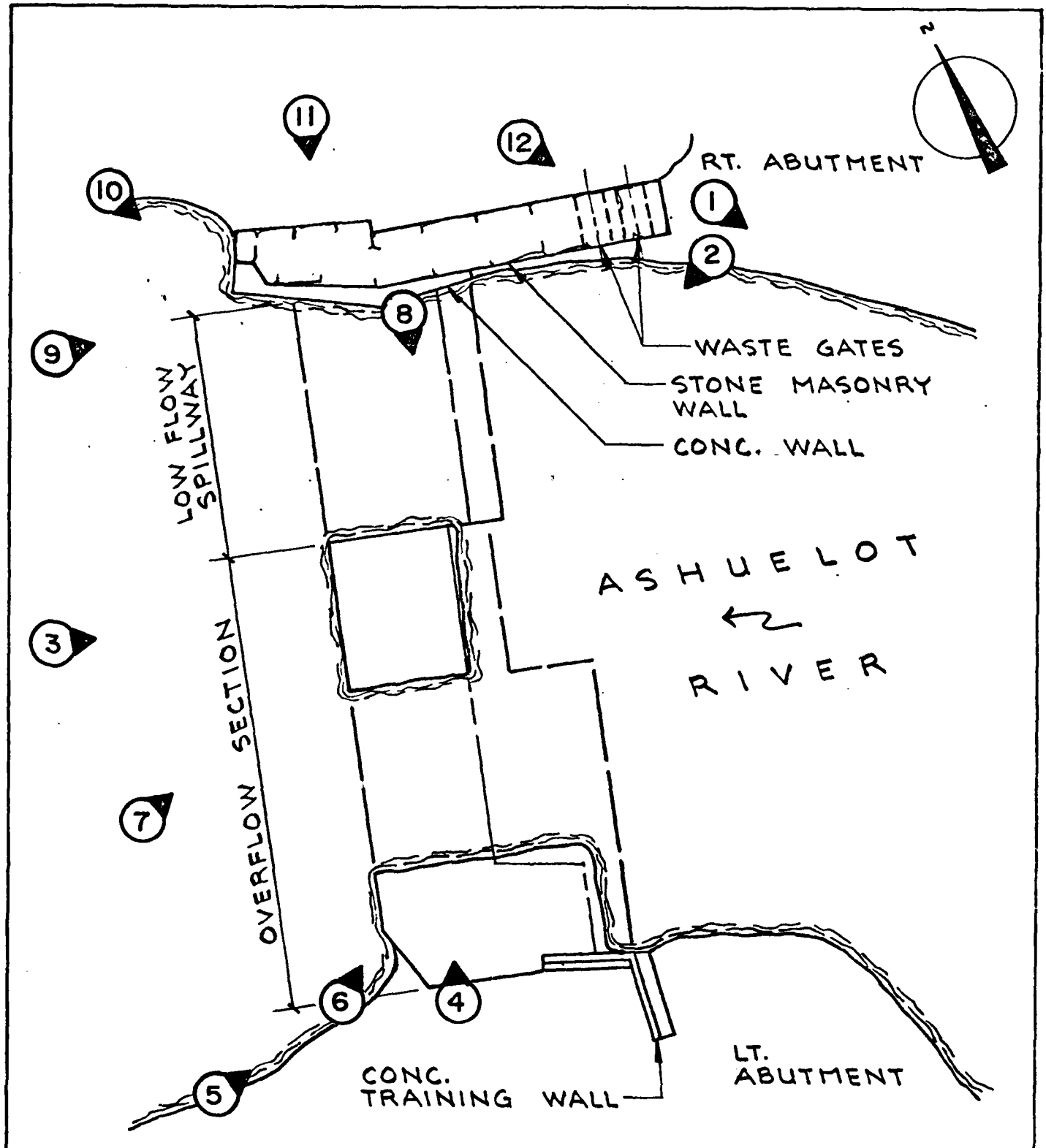
PLANS AND DETAILS



REPRODUCED AT GOVERNMENT EXPENSE

APPENDIX C

SELECTED PHOTOGRAPHS



SEA CONSULTANTS INC. BOSTON, MA — ROCHESTER, NH	U.S. ARMY ENGINEER DIV NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MA

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

ROBERTSON DAM
PHOTO INDEX

WINCHESTER, NEW HAMPSHIRE

SCALE AS NOTED
DATE JULY 1980

Photo No. 1 - View of upstream channel from right abutment.

Photo No. 2 - View of crest of dam and downstream channel from right abutment.

Photo No. 5 - View of downstream face of left abutment.

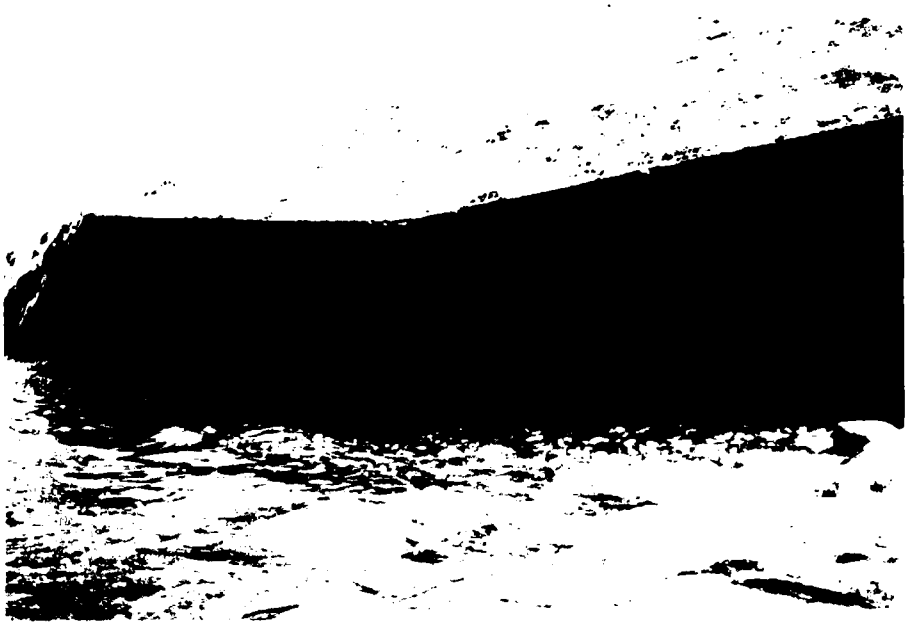


Photo No. 6 - Closeup view of downstream face of overflow section near left abutment.

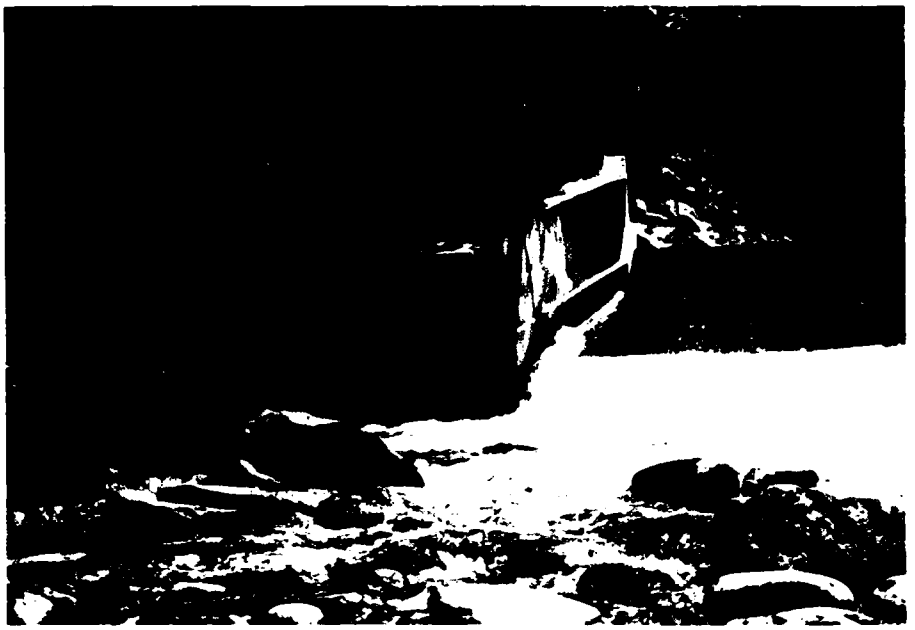
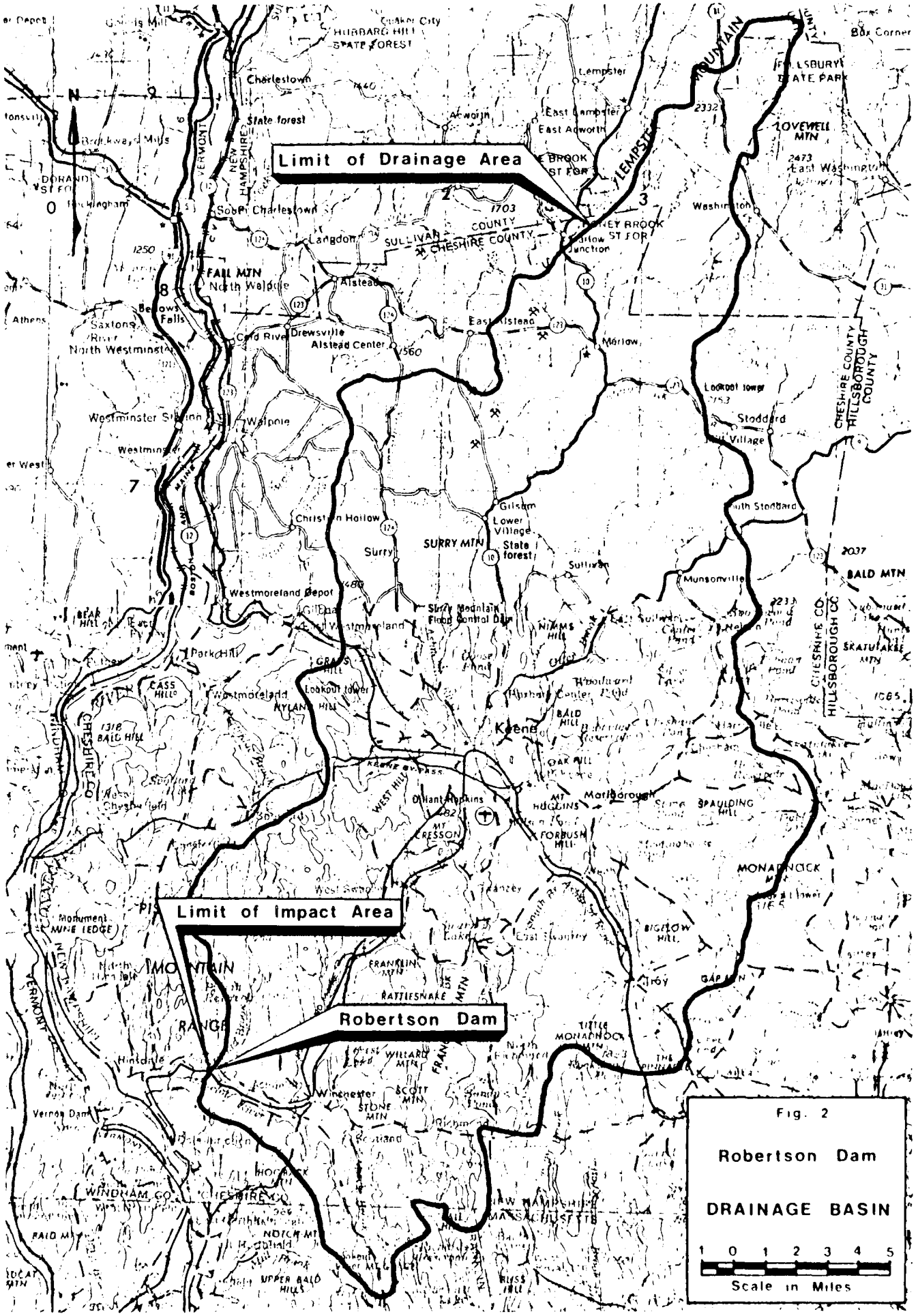


Photo No. 9 - View of right training wall from downstream channel.

Photo No. 10 - Closeup view of downstream face of right training wall.

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS


Limit of Drainage Area
Limit of Impact Area
Robertson Dam
Charlestown
Claremont
Newport
Sunapee
Lempster
East Lempster
Acworth
East Acworth
Langdon
Alstead
East Alstead
Drewsville
Alstead Center
Walpole
Westminster Station
Westminster
North Westminster
Bellows Falls
Saxtons River
Athens
Rockingham
Brockways Mills
Christian Hollow
Surry
Gilsum
Lower Village
Westmoreland Depot
Westmoreland
Park Hill
Keene
Marlborough
Munsonville
Sullivan
Stoddard
South Stoddard
Marlow
Winchester
Hinsdale
Vernon Dam
Monument Mine Ledge
Fall Mtn
Surry Mtn
Bald Mtn
Lovewell Mtn
Monadnock
Little Monadnock Mtn
Pisgah State Park
Fitzwilliam
Troy
Gap Mtn
Spaulding Mtn
Mt Huggins
Forbush Hill
Oak Hill
Bald Hill
Grass Hill
Nims Hill
Skatutakee Mtn
Scott Mtn
Stone Mtn
Rattlesnake Mtn
Notch Mt
Upper Bald Hills
Green Mtn
Hogback Mtn
Vermont
New Hampshire
Massachusetts
Windham Co.
Cheshire Co.
Hillsborough Co.
Cheshire County
Sullivan County
Hillsborough County
Connecticut River
Ashuelot River
Millers River
Cold River
Saxtons River
Flood Control Dam
Hubbard Hill State Forest
Pisgah State Park
Surry Mtn State Forest
Fitzwilliam
Box Corner
Fig. 2
Robertson Dam
DRAINAGE BASIN
1 0 1 2 3 4 5
Scale in Miles

I. Basin Data

A. Drainage Area

1. 406 square miles – as defined on U.S.G.S. sheets and then planimetered

2. drainage area –
   a. Topography quite variable ranging from mountainous to moderately sloped terrain
   b. Numerous ponds, lakes and swampy areas located throughout drainage basin
   c. Two major Corps of Engineers flood control dams located in drainage basin
      (1) Surry Mountain Dam – ≈ 100 sq. mi. drainage area above the dam, or about one-fourth of total drainage area
      (2) Otter Brook Dam – ≈ 47 sq. mi. of drainage area
   d. There are also numerous small dams located on lakes and rivers within the drainage area as well as additional dams in the Ashuelot River upstream from the Robertson Dam

B. Dam and Storage Information

1. Size Classification: SMALL based on storage (≥ 50 acre-feet and < 1,000 acre-feet)

   as noted below the storage at the Robertson dam was estimated to be 112 acre-feet

2. Hazard Potential: Significant

3. Storage Information

Descriptive Information	Elevation (feet)	Surface Area (acres)	Storage (acre-feet)
395 Contour on 1933 map	395	14	
Top of left training wall. (crest of dam	387.1	10.8	112
crest low flow spillway	330.46	3	50

* Notes: (1) Elevations: NGVD

C Spillway Information

1. Run of the river type dam with concrete capped spillway. The spillway has a 35 feet long non-flow section located near the right abutment. The remainder of the spillway is about 66 feet long as measured from the left training wall to the non-flow section.

2. The discharge over spillway will be computed using the broad-crested weir equation

$$Q = C L H^{3/2}$$ (Standard handbook for CE: Merritt,

where: Q = discharge, CFS.
L = weir length, feet

H = head over weir, feet
C = discharge coefficient, use C = 3.97 for weir with both faces rounded (Table 5-8 Handbook of Hydraulics Brater + King)

II. Estimate Effect of Surcharge Storage on Maximum Probable Discharge

A. Develop stage-discharge curve for outflow from dam complex

1. define sources of outflow

a. discharge over spillway - above elevation 380.46 using broadcrested weir equation as defined above
(1) ignore small section broken out of low flow spillway section

b. discharge over left training wall - above elevation 356.6 feet - using broadcrested weir eq.

c. discharge over right training wall - above elevation 388.01 - using broadcrested weir equation

d. discharge over right portion of dam - stone masonry structure - above elevation 389.45, use broadcrested weir equation

e discharge over abutments

2 Spillway discharge

a. Low flow spillway (ignoring broken out section)

Elevation feet (NGVD)	C	L feet	H feet	Q_{SP1} cfs
380.46	3.87	35	0	0
381			0.54	50
382			1.54	260
383			2.54	550
384			3.54	900
385			4.54	1,310
386			5.54	1,770
387			6.54	2270
388			7.54	2,800
389			8.54	3,380
390			9.54	3,990
391			10.54	4,630
392			11.54	5,310
394			13.54	6,750

b. Depressed portion of remainder of spillway

Elevation feet (NGVD)	C	L feet	Avg, H feet	Q_{SP2} cfs
381.40	3.87	—	0	0
382		45	0.4	40
383		53	1.3	300
384			2.3	720
385			3.3	1,230
386			4.3	1,830
387			5.3	2,500
388			6.3	3 240
389			7.3	4,050
390			8.3	4,900
391			9.3	5 820
392			10.3	6,790
394		—	12.3	8,850

c. Remainder of spillway adjacent to left training wall

Elevation feet (NGVD)	C	L feet	H feet	Q_{SP3} cfs
382.54	3.87	≈12	0	0
383			0.46	10
384			1.46	90
385			2.46	190
386			3.46	300
387			4.46	430
388			5.46	590
389			6.46	760
390			7.46	950
391			8.46	1,140
392			9.46	1,350
394			11.46	1,800

d. Summary of spillway discharge

Elevation feet (NGVD)	Q_{SP1}	Q_{SP2}	Q_{SP3}	Q_{SP} TOTAL
380.46	0	0	0	0
381	50	0	0	50
382	260	40	0	300
383	550	300	10	860
384	900	720	90	1,700
385	1310	1,230	190	2,720
386	1,770	1,830	300	3,900
387	2,270	2,500	430	5,200
388	2,800	3,240	590	6,630
389	3,380	4,050	760	8,190
390	3,990	4,900	950	9,840
391	4,630	5,820	1,140	11,590
392	5,310	6,780	1,350	13,440
394	6,750	8,850	1,800	17,400

3. Discharge over left training wall

Elevation feet (NGVD)	C	L feet	Avg. H feet	Q cfs
387.10	3.0	28	0	0
388	↓	↓	0.9	70
389			1.9	220
390			2.9	410
391			3.9	650
392			4.9	910
394			6.9	1,520

4. Discharge over left abutment

Elevation feet (NGVD)	C	L feet	Avg H feet	Q cfs
387.15	2.6	0	0	0
388	↓	60	0.4	40
389		70	1.4	300
390		↓	2.4	680
391			3.4	1,140
392			4.4	1,650
394			6.4	2950

5. Discharge over right training wall and stepped stone masonry portion of dam

Elevation feet (NGVD)	C	L feet	Avg H feet	Q cfs
393.01	2.65	1.5	0	0
389	↓	1.5	≈1	≈5
390		9	0.8	20
391		20	1.2	70
392		22	2.2	190
394		22	4.2	500

6. Discharge over remainder of dam and right abutment

Elevation feet (NGVD)	C	L feet	Avg. H feet	Q cfs
≈ 391.5	2.65	—	0	0
392	↓	15	0.25	5
394	↓	85	1.75	520

7 Summary of discharge from dam site

Elev. ft (NGVD)	Q Spillway	Q left train. wall	Q left abut	Q right dam	Q right abut	Q TOTAL
380.46	0	0	0	0	0	
381	50	↑	↑	↑	↑	50
382	300	↑	↑	↑	↑	300
383	860	↑	↑	↑	↑	860
384	1,700	↑	↑	↑	↑	1,700
385	2,720	↑	↑	↑	↑	2,720
386	3,900	↑	↑	↑	↑	3,900
387	5,200	0	0	↓	↑	5,200
388	6,630	70	40	0	↑	6,740
389	8,190	220	300	5	↑	9,715
390	9,990	410	680	20	↑	10,950
391	11,590	650	1,140	70	0	13,450
392	13,440	910	1,680	90	5	16,125
394	17,400	1,520	2,950	500	520	22,990

Discharge vs Elevations summarized graphically in Figure 1

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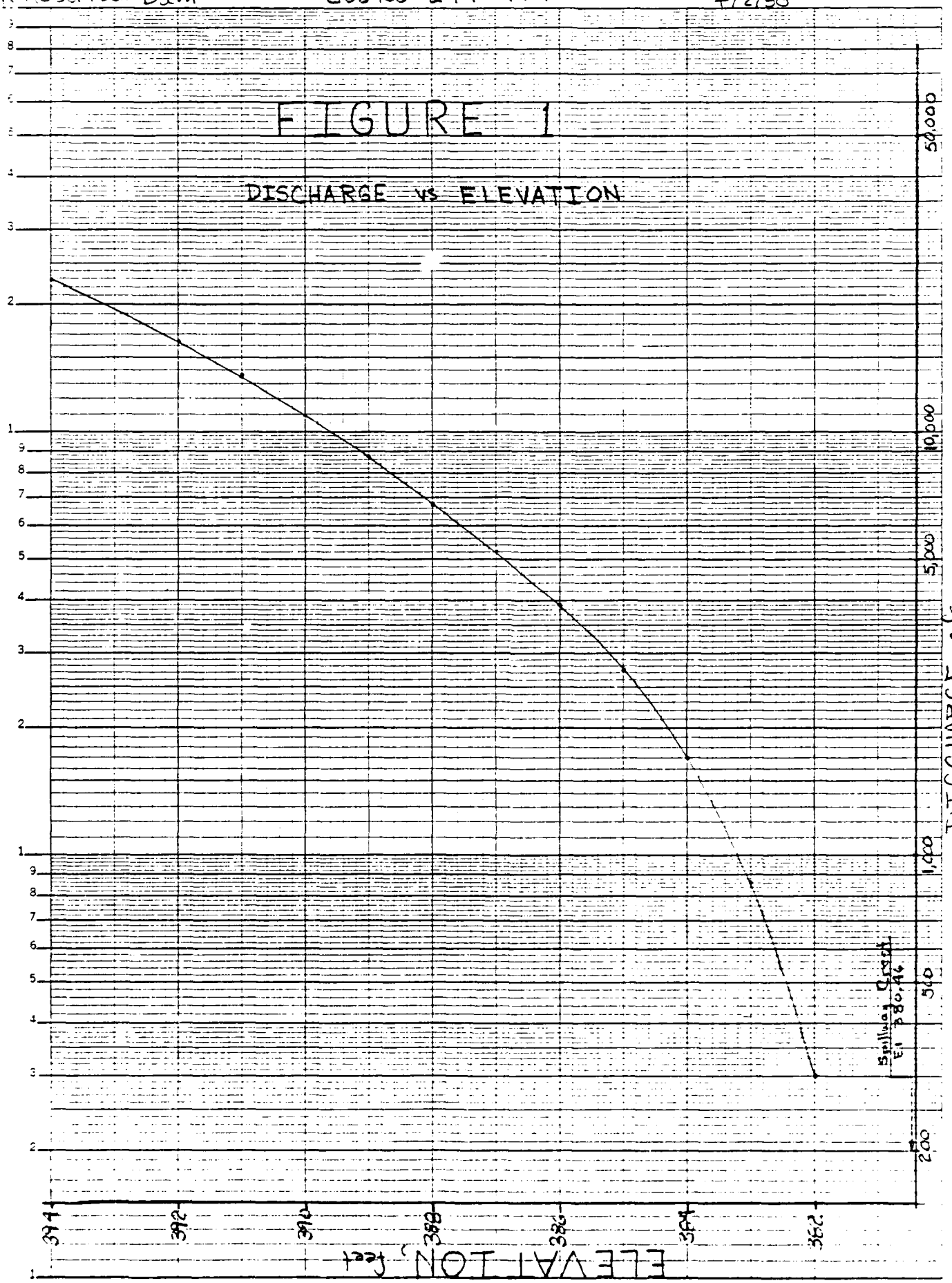
FIGURE 1

DISCHARGE vs ELEVATION



Semi-logarithmic
cycles x 10 to the inch

B. Effect of surcharge storage on maximum probable discharge

1. Pertinent Data

a. Drainage area = 406 square miles

b Characteristics of basin – topography ranges from mountainous to moderately sloped, however there are numerous ponds, lakes, swampy areas, small dams and two major flood control dam in drainage area

c. Test flood = 100-yr storm event

d. Follow Army Corps' procedure for determining routed test flood outflow

2 STEP 1: Determine Peak Inflow, Q_{P1}

a. Since information relevant to projected flood discharges was available through a flood plain insurance study prepared for the Federal Emergency Management Agency, the estimate for the discharge associated with the 100yr storm event was based on this data rather than the Corps of Engineers Guide Curves. It was estimated that the probable discharge at the Robertson Dam would be approximately 9,150 cfs for the 100-yr storm event

3. STEP 2: Determine surcharge height to pass Q_{P1}, $STOR_1$, and Q_{P2}

a. from Figure 1 determine surcharge height to pass $Q_{P1} = 9,150$ cfs

Surcharge elevation ≈ 389.2 ft
Spillway crest elevation ≈ 380.5 ft
Surcharge height = 8.7 ft

b. determine volume of surcharge $STOR_1$ in inches of runoff

first determine Storage in acre-feet

(1) determine pond surface area at surcharge elevation from Figure 2 ≈ 1.6 acre-ft

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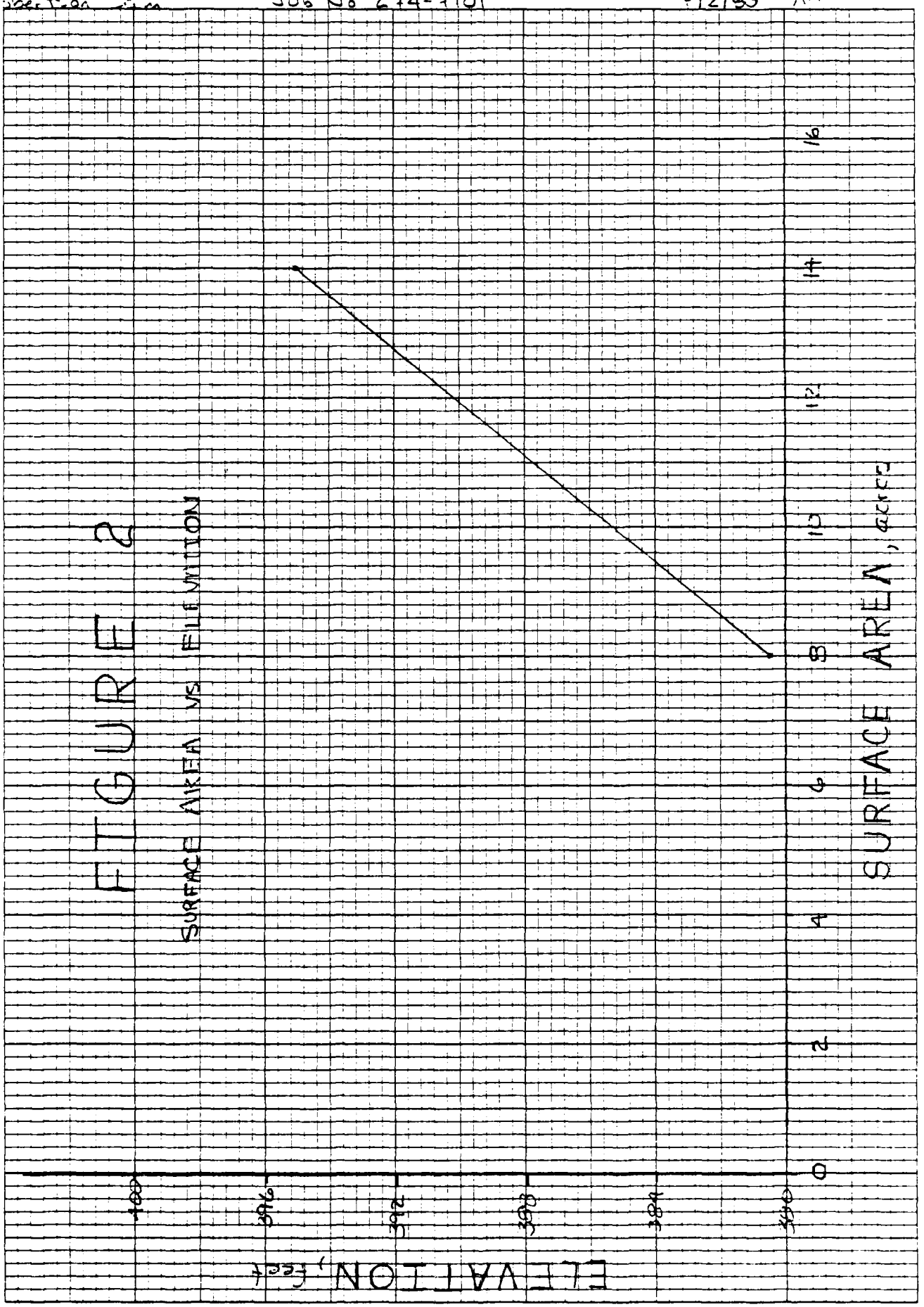

(2) average surface area for surcharge elevation and spillway crest

(3) multiply average surface area by surcharge height inserting in equation below

$$STOR_1 = \frac{\text{Volume of storage (as acre-inches)}}{\text{drainage area}}$$

$$STOR_1 = \frac{\left[\left(\frac{8\text{ acres} + 11.6\text{ acres}}{2}\right)(8.7\text{ ft})\right](12''/\text{ft})}{(406\text{ sq. mi})(640\text{ acre/sq. mi})}$$

$STOR_1 = 0.0039$ inches

c. determine Q_{P2}.

$$Q_{P2} = Q_{P1}\left(1 - \frac{STOR_1}{4.75''}\right)$$

$$Q_{P2} = (9{,}150\text{ cfs})\left(1 - \frac{0.0039''}{4.75}\right)$$

$Q_{P2} \approx 9{,}140$ cfs

It is apparent from the previous calculations that very little surcharge storage is available upstream from the Robertson Dam. Consequently the routed test flood outflow will essentially be equal to the test flood inflow. Furthermore we will accept the routed test flood outflow equal to 9,140 cfs at a surcharge elevation of 389.2 feet, since any additional iterations will yield these same values

4 In Conclusion

a. The routed test flood discharge of 9,140 cfs will overtop the dam (left training wall) by about 2.1 feet

b. Spillway capacity

(1) water surface at top of left training wall (top of dam) – elevation 397.10

from Figure 1 $Q \approx 5{,}300$ cfs

(2) water surface at test flood elevation

(a) $Q = (3.87)(35)(389.2 - 380.46)^{1.5}$
$\approx 3{,}500$ cfs

(b) $Q = (3.87)(53)(7.5)^{1.5}$
$\approx 4{,}210$ cfs

(c) $Q = (3.87)(12)(6.66)^{1.5}$
≈ 800 cfs

(d) $Q_{TOTAL} = 3{,}500$ cfs + 4,210 cfs + 900 cfs $\approx$ 8,510 cfs

III Using "Rule of Thumb" Guidance for Estimating Downstream Failure Hydrographs examine impact of dam failure

A. Since the length of the spillway is large compared to the total length of the dam, the tailwater resulting from discharge over the spillway with the water surface at the crest of dam may be significant

1. from previous calcs the steady state discharge over the spillway with the water surface at crest of dam (top of left training wall) is approximately equal to 5,300 cfs (see page D-9, Fig. 1)

2 Using the stage - discharge curve prepared for routing of failure discharge through stream reaches determine the stage for the steady state discharge.

a. Reach 1 - from Figure 3 stage ≈ 7.0 feet

Note: FPI Study for Winchester lists tailwater depth of 9.4 ft immediately below the dam for 100-year flood (Q=9,150 cfs). The stage-discharge curve prepared for this report (Figure 3, p D-19) shows a stage of about 9.5 ft for Q = 9,150 cfs. These tailwater elevations compare favorably.

3. The failure discharge should now be computed and routed through the stream reaches using the "Rule of Thumb" Guidance for Estimating Downstream Failure Hydrographs. If the hazard resulting from the failure discharge is significantly increased over the steady state discharge, the hazard classification for the Robertson Dam will be defined by the routing procedure. If there is no significant increase in hazard over the steady state discharge, the hazard classification [illegible] failing the dam with the water surface at the spillway crest. D-14

B. Reach 1

1. STEP 1: Determine reservoir storage at time of failure - water surface at top of left training wall - elevation ≈ 387.1 feet

Storage ≈ 112 acre-feet

2. Determine Peak Failure Outflow, Q_{P1}

a. $Q_{P1} = (8/27)\, W_b\, g^{1/2}\, Y_o^{3/2}$

where: W_b = Breach width (max 40% of dam length)
= (0.4)(150 ft)
= 60 feet

Based on the general condition of the right stone masonry section this appears to be the most likely location for failure. This would include about a 40 feet section of the wall, plus a section of the flow spillway

Y_o = Total height from top of dam to channel bottom
= 387.1 ft − 370 ft
= 17.1 feet

$$Q_{P1} = (8/27)(60\text{ feet})(32.2)^{1/2}(17.1\text{ ft})^{3/2}$$

$Q_{P1} \approx 7{,}130$ cfs

b. Q over unfailed portion of spillway

$$Q_{unfailed} = 5{,}300\text{ cfs} - (3.37)(20)(387.1 - 380.4)^{3/2}$$
$$\approx 3{,}990\text{ cfs}$$

c. $Q_{P1\,(TOTAL)} = 7{,}130\text{ cfs} + 3{,}990\text{ cfs} \approx 11{,}100$ cfs

3. STEP 3: Prepare stage-discharge curve for Reach 1

a. Pertinent Data

(1) Reach length = 400 feet
(2) Channel slope = 0.01
(3) Manning n = 0.06 channel flow, 0.08 overbank flow
(4) Channel shape - trapezoidal
(5) Base width ≈ 100 feet

b. See Figure 3 for stage-discharge curve

4 STEP 4: Estimate Reach Outflow

a. Determine stage for Q_{P_1} = 11,100 cfs from Figure 3 and find volume in reach

(1) Stage (depth of flow) = 3.6 feet (Total Stage ≈ 10.6 ft above prefailure tailwater

(2) Volume in reach = (reach length) (cross-sectional area of channel)

$$\text{X-area} = (0.5)(3.6\text{ ft})(175 + 215\text{ ft})$$
$$= 702\text{ ft}^2$$

$$\text{Volume} = V_1 = \frac{(702\text{ ft}^2)(400\text{ ft})}{43{,}560\text{ ft}^2/\text{acre}}$$

$$= 6.4\text{ acre-ft}$$

$V_1 < \frac{S}{2}$ ∴ reach length OK

b. Determine $Q_{P2(TRIAL)}$

$$Q_{P2(TRIAL)} = Q_{P1}\left(1 - \frac{V_1}{S}\right)$$

$$Q_{P2(TRIAL)} = (11{,}100\text{ cfs})\left(1 - \frac{6.4\text{ ac-ft}}{122\text{ ac-ft}}\right)$$

$$Q_{P2(TRIAL)} \approx 10{,}500\text{ cfs}$$

c. Compute V_2 using $Q_{P2(TRIAL)}$

From Figure 3 determine stage for $Q_{P2(TRIAL)}$

Stage = 3.3 feet above prefailure tailwater (Total Stage = 10.3 ft)

X-area = (0.5)(3.3 ft)(175 ft + 215 ft)
$\approx 644\ ft^2$

$$V_2 = \frac{(644\ ft^2)(400\ ft)}{43{,}560\ ft^2/acre}$$

$V_2 = 5.9$ acre-ft

d. Average V_1 and V_2 and compute Q_{P2}

(1) $$Vavg = \frac{V_1 + V_2}{2}$$

$$Vavg = \frac{6.4\ ac\text{-}ft + 5.9\ ac\text{-}ft}{2}$$

$Vavg \approx 6.2$ acre-ft

(2) $$Q_{P2} = Q_{P1}\left(1 - \frac{Vavg}{S}\right)$$

$$Q_{P2} = (11{,}100\ cfs)\left(1 - \frac{6.2\ ac\text{-}ft}{1220\ ac\text{-}ft}\right)$$

$Q_{P2} \approx 10{,}500$ cfs

C. Conclusions from failure discharge routing

1. The failure discharge will increase the stage in the immediate downstream reach about 3 to 4 feet above the stage of the pre failure discharge. This increase in stage will cause water to rise to about 2 to 3 feet above the sill of portions of the mill buildings located adjacent to the river a short distance below the dam. The pre failure discharge was about 1 foot below the sill of this building. Due to the significant increase in stage resulting from the dam failure discharge and the potential economic loss resulting from this discharge the dam will be classified as a significant hazard on the basis of the preceding dam failure analysis.

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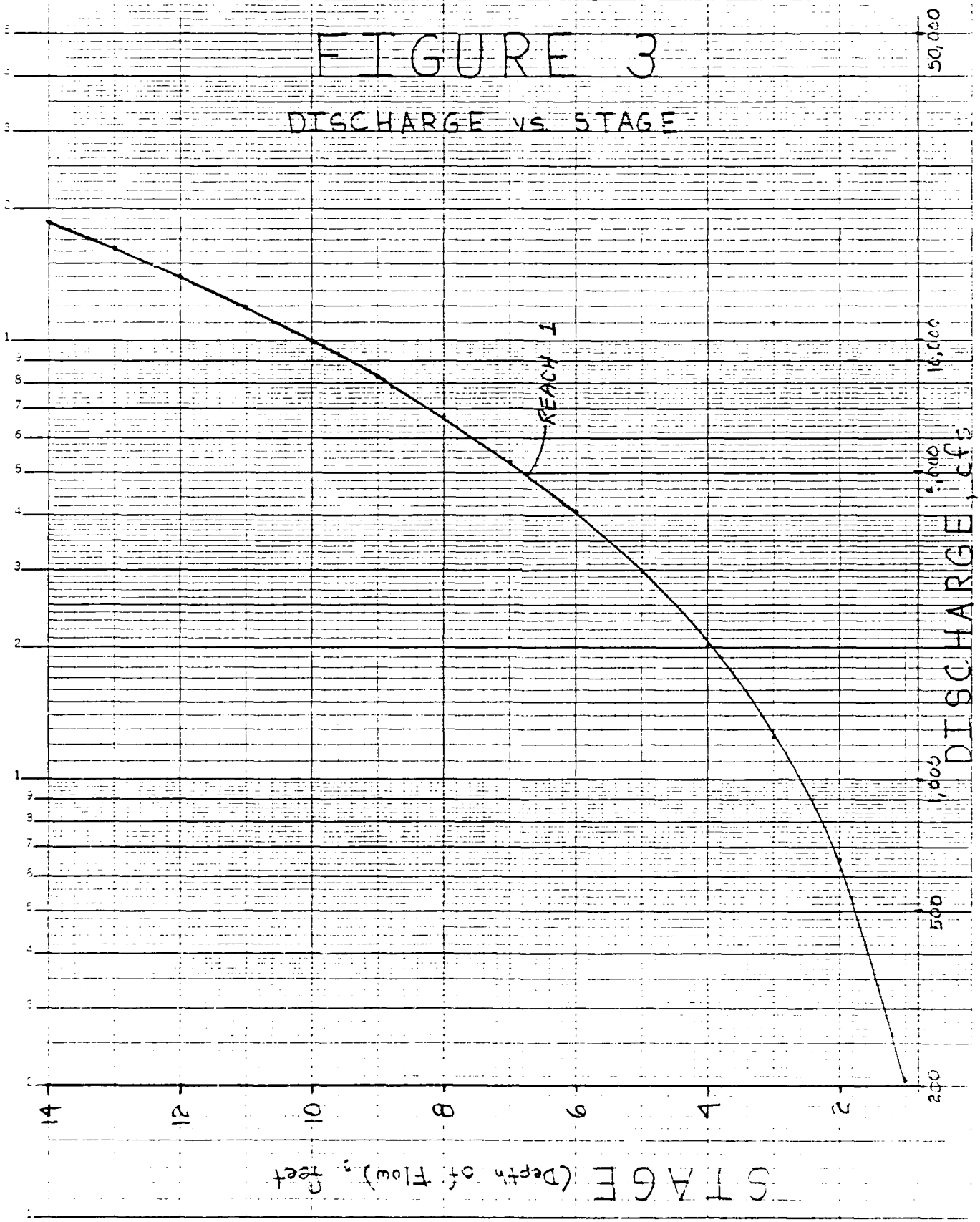
FIGURE 3

DISCHARGE vs STAGE



APPENDIX E

INFORMATION AS CONTAINED IN

THE NATIONAL INVENTORY OF DAMS

END

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